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OF
SABINE PARISH, LOUISIANA

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Water Resources Bulletin No. 3

WATER RESOURCES OF SABINE PARISH, LOUISIANA

by

LELAND V. PAGE, ROY NEWCOME, JR., AND
GEORGE D. GRAEFF, JR.

U. S. GEOLOGICAL SURVEY

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WATER RESOURCES OF SABINE PARISH, LOUISIANA

By Leland V. Page, Roy Newcome, Jr., and George D. Graeff, Jr.

WATER RESOURCES BULLETIN NO. 3 May 1963

ABSTRACT

Sabine Parish, in the Tertiary uplands of northwestern Louisiana, has limited amounts of ground water and surface water available for current and future demands. The principal water problems in the parish pertain to water supply for industrial expansion and municipalities, flood control, drainage, irrigation, navigation, pollution, and salt contamination. The town of Many depends on ground water for its source, and some consideration has been given to the possibility of developing an additional supply from streams. Several nearby streams hold promise of an adequate supply of satisfactory quality with development. Bayou Negreet has been pumped dry by those using water for irrigation. The main problem in the use of water from the Sabine River is one of distribution—to make the water available to the more remote areas. Toledo Bend Reservoir will help alleviate this problem by creating a large reservoir which will be within easy reach of most principal communities in the parish. There are potential pollution problems from occasional releases of oil-field brine.

Only small quantities of surface water have been used for domestic or industrial purposes in Sabine Parish. Waters from Bayou Toro and Bayou Negreet have been used for irrigation during dry seasons. Except in the vicinities of a few towns the ground-water resources have been relatively untapped. Most wells are used for domestic and farm supplies and are constructed to yield only a few gallons per minute, but several wells yielding 50 to 250 gpm (gallons per minute) are owned by municipalities in the parish. In addition, there are a few wells yielding 40 to 100 gpm serving industries.

The largest source of surface water in the parish is Sabine River which drains approximately 5,300 square miles upstream from the parish. The Sabine River has an average flow of about 3,600 cfs (cubic feet per second) or about 2,300 mgd (million gallons per day). Many of the streams that drain the upland area are not dependable sources of supply because their flows are not well sustained during dry seasons.

The annual precipitation over the parish is about 52 inches of which about 18 inches becomes runoff, which is equivalent to a continuous flow of about 1.33 cfs per square mile. Seasonal and annual runoff varies considerably, but no significant trends have been noticed.

Sabine River affords the most dependable surface-water supply, without artificial storage. Bayou Toro has a well-sustained base flow and is probably the second-best source of supply. Many of the other streams in the parish can probably provide a good surface-water supply for a small city if storage facilities are provided. For instance, the average flow of Bayou San Miguel near Zwolle for the 10-year period 1949-58 was about 68 mgd, but because there was no flow for short periods in every year, proper utilization would require storage space.

Considerable variation in the chemical character of the Sabine River water occurs throughout the year. It is generally of excellent quality, but danger of periodic contamination from East Texas oil fields does exist. Water in the smaller streams within the parish are generally low in dis-

solved solids, chloride, and sulfate. Periodic analyses indicate that salt contamination sometimes occurs in Bayou San Patricio. This contamination may also occur in unsampled streams. These waters would be suitable for public supplies without softening, but would probably need treatment to remove color and suspended material.

The exposed rocks are sedimentary and consist of lignitic sand and clay ranging in age from early Eocene to late Miocene and alluvial sand and clay of Quaternary age. The controlling geologic structure of the region is the Sabine uplift, a structural dome centered in De Soto Parish. Sabine Parish is on the southern flank of the dome where banded outcrops of the southward-dipping strata reflect the uplift and subsequent erosion. In the northern two-thirds of the parish sediments of the Wilcox Group of Paleocene and Eocene age constitute the outcrops. South of the Wilcox are outcrops successively of the Claiborne Group and the Jackson Group of Eocene age, the Vicksburg Group of Oligocene age, and the beds of Miocene age. The Sabine River, which forms the western boundary of the parish, occupies an entrenched valley filled with Quaternary alluvium and flanked by highly dissected discontinuous remnants of Pleistocene terraces.

Ground water in the sands of the Tertiary formations is confined in most places by overlying beds of clay and occurs under artesian conditions. Water-bearing sands are in the Sparta Sand and Cockfield Formation of the Claiborne and Wilcox Groups and the Catahoula Formation.

The sands range widely in thickness and texture. They are recharged by rainfall in their areas of outcrop and are partly drained by the stream valleys that are cut into the outcrops. Water supplies are obtained from these sands through wells—dug, driven, or drilled, ranging in depth from 10 to 600 feet. Water from the Tertiary sands is soft and of generally good chemical quality; the most common objectionable constituent is iron, which ranges considerably in concentration from place to place.

Ground water in the Quaternary terrace deposits and valley alluvium is generally unconfined and, except in

places where a clay mantle induces local artesian conditions, it occurs under water-table conditions. The small outcrop area of the terrace deposits, their dissected condition, and their elevated position combine to make them unreliable sources of water supply. The valley sands, which are recharged by rainfall in the valleys and by drainage from the more elevated Tertiary sands, are generally thin and irregular in texture. Domestic and farm wells obtain adequate supplies of good water from these sands, but no wells yielding more than a few gallons per minute have been developed.

In the southern part of the parish are two of the better water-bearing formations of northern Louisiana—the Sparta Sand and the Catahoula Formation, which have been relatively untapped. This is due in part to the rugged topography which has encouraged little development and is covered largely by timber in this part of the parish. In the northern part of the parish all water-bearing sands are in the thick section of Wilcox. The towns of Many, Pleasant Hill, Zwolle, and Converse, and some industries obtain water from sands of the Wilcox Group.

INTRODUCTION

PURPOSE AND SCOPE

A study of the geology and water resources of Sabine Parish was undertaken as a part of the program of water-resources investigations by the U.S. Geological Survey in cooperation with the Louisiana Department of Public Works and the Louisiana Geological Survey, Department of Conservation. The purpose of the study was to determine the geologic and hydrologic conditions relating to the occurrence, quantity, and chemical quality of water in Sabine Parish.

This report presents an evaluation of the water resources of Sabine Parish with respect to present and potential use. It is intended for initial guidance in future development of water supplies in the parish. It does not resolve all questions relating to water-supply needs in any specific location. The many factors involved will usually call for more detailed local investigations.

DESCRIPTION OF AREA

Location and Extent

Sabine Parish, in the northwestern part of Louisiana, (see pl. 1) is bordered on the west by the Sabine River and the State of Texas, on the north by De Soto Parish, on the northeast and east by Natchitoches Parish, and on the south by Vernon Parish. The parish has a total land area of 1,029 square miles and is included in townships 2-10 N., ranges 9-15 W.

Historical Summary

The Sabine Parish area was at one time claimed by both France and Spain, and after the Louisiana Purchase in 1803, by Spain and the United States. Not until 1820 was the western boundary of Louisiana fixed at the Sabine River, and during the intervening years the area was a part of a neutral strip and a refuge for desperadoes. One of the main colonization and trade roads to Texas, El Camino Real, traversed the area; and Fort Jesup was a thriving frontier post on the road after 1820. The fort was a stop-

over place for many Texas immigrants and a staging point for federal troops during the Mexican War; it was closed after the war when Texas was annexed by the United States. Sabine Parish with its parish seat at Many was formed March 7, 1843, from the county of Natchitoches (now Natchitoches Parish).

Landforms and Relief

Sabine Parish is in the Gulf Coastal Plain, a region of low and rounded topography. The hills are generally 80 to 100 feet higher than the flood plains of the major streams, but altitudes within the parish range from less than 100 to nearly 400 feet. There are three principal topographic divisions in the parish: the upland, the terraces, and the flood plains. Uplands include about three-quarters of the parish and consist of rolling hills underlain by the older formations of the Coastal Plain. The flood plains and terraces are flat and benchlike and are underlain by redeposited sediments of more recent fluviatile origin.

In most of the parish a few prominent topographic features indicate a marked difference in the comparative resistance of the formations to erosion. However, near the southeastern boundary of the parish resistant sandstones form a northward-facing escarpment known as the Kisatchie Wold, which extends northeastward across the parish and continues eastward through Natchitoches Parish and westward into Texas.

The highest point in the parish, having an altitude of 480 feet, is south of the Wold and a short distance west of the Sabine-Vernon Parish boundary near Hornbeck.

The Sabine River has trenched a meandering course in a flood plain that ranges in width from 1 to 5 miles. Many meander scars show that the river has occupied various channels as it migrated back and forth across the plain. Flood plains of the principal tributary streams are bordered discontinuously by terraces which are erosional remnants of older and higher flood plains.

Drainage

There are no large lakes in Sabine Parish, but several

small lakes and ponds are in the central part of the parish. The largest is Loring Lake which has a water surface area of approximately 0.1 square mile, or 64 acres at its normal stage. Loring Lake was formed artificially for watering of steam engines by the Kansas City Southern Railroad.

There are numerous small oxbow lakes that were formed by the Sabine River as a result of its meandering over the years. The largest of these lakes are McCarthney Lake and Blue Lake, although not any one of these is larger than 2 acres in surface area under normal climatic conditions. The parish contains about 5.5 square miles of swampy area along the Sabine River, most of which is in the southern tip of the parish.

The major part of the drainage is to the south and southwest by means of numerous streams and arteries which form a dendritic pattern and flow into the Sabine River. The general drainage pattern in Sabine Parish is illustrated on plate 1. A narrow strip approximately 2 to 7 miles wide along the eastern boundary of the parish drains to the east to the Red River Basin via Bayou Dupont, Bayou Pedros and small tributaries of Bayou Pierre, Bayou Santabarb, and Kisatchie Bayou in Natchitoches Parish.

Bayou Dupont and Bayou Pedros are two of the larger streams draining to the east. The principal streams directly tributary to Sabine River within the parish are Bayou San Patricio, Bayou San Miguel, Bayou La Nana, Bayou Negreet, and Bayou Toro. Other tributaries to Sabine River include Cow Bayou, Bear Creek, Bossier Bayou, and McDonald Bayou.

The Sabine River originates in northern Hunt county and eastern Collin and Rockwall counties in north-central Texas. The source divide is at elevation 690 feet above mean sea level and approximately 578 river miles above the mouth. The river flows southeasterly across Texas for 300 miles, then turns in a more southerly direction and forms the boundary between Louisiana and Texas. The drainage basin is long and narrow, its total length being about 290 miles, with an average width of 34 miles. The basin does not exceed 45 miles in width at any one point. Under aver-

age climatic conditions river flow is confined to a channel which meanders across the valley and has numerous sloughs, overflow channels, marshes, and bayous. Stream-bed gradients are low; for the 194-mile reach between Mineola, Texas, and the Logansport, La. gages, the average fall is 0.8 foot per mile, but in the reach below Logansport and south to the gage at Bon Wier, Texas, the fall averages 0.6 foot per mile for 169 miles.

Bayou San Patricio, a tributary to the Sabine River, originates in southern De Soto Parish at elevation 250 and flows southwesterly across De Soto and northwestern Sabine Parishes for about 36 miles and discharges into Sabine River. Fall throughout its course averages 3 feet per mile.

Following an almost parallel course to Bayou San Patricio approximately 4 miles to the east is Bayou San Miguel. It originates immediately north of Pleasant Hill at about elevation 300 feet above mean sea level. Fall throughout its reach averages 3.4 feet per mile in its 44 miles of length. Bayou Scie empties into Bayou San Miguel from the east in the vicinity of Zwolle and has White Lick, Sneed, and Brushy Creeks as its tributaries. Little Bayou San Miguel drains the area south of Pleasant Hill and enters Bayou San Miguel from the east about 6 miles southwest of Pleasant Hill.

Farther to the south Bayou La Nana flows practically due west into the Sabine River 14 miles west of Many. It is formed by the joining of Harpoon Bayou and San Jose Creek about a mile west of Many. Bayou La Nana very nearly parallels Louisiana Highway 6 from its beginning just west of Many for a distance of 20 miles to its mouth, and has a stream gradient averaging 3 feet per mile. Tributaries to Bayou La Nana include Hurricane Creek and Lewis Creek.

Bayou Negreet intercepts the drainage between Bayou La Nana to the north and Bayou Toro to the south. Bayou Negreet originates in the hills north of Negreet at about elevation 240 and flows southwesterly for 20 miles to join Sabine River. Its bed slope averages 5 feet per mile. Turner and Salter Creeks are the principal tributaries to Bayou Negreet.

Bayou Toro drains the southern tip of the parish and flows southwesterly to Sabine River. The southernmost reach of Bayou Toro forms the boundary between Sabine and Vernon Parishes. Bayou Toro rises in the vicinity of Mt. Carmel, is about 29 miles in length, and has an average bed slope of 3 feet per mile.

Bayou Dupont rises in the northeastern part of the parish between the towns of Many and Robeline at an elevation of about 300 feet above mean sea level and flows in a northeasterly direction into Natchitoches Parish to a junction with Little River about 4 miles north of Robeline. It has a fairly steep stream gradient, falling about 100 feet in a distance of about 21 miles. The largest tributary is Bayou Pedro, which joins Bayou Dupont near Robeline.

Climate

Sabine Parish lies within the humid zone of the United States. The average annual temperature in the parish is 66°F; summer temperatures average about 81°F. The mild spring and fall weather is sufficiently warm to afford long growing seasons. Winters are short and mild, the average temperature being 51°F. Temperatures seldom go below freezing, and the average frost-free period is about 230 days. The average annual precipitation during the standard 30-year period, 1921-50, computed by the Thiessen polygon method (Johnstone and Cross, 1949) from records for four Weather Bureau stations in the surrounding area is about 52 inches.

As there are no continuous records of temperature and precipitation for stations within the parish, values shown in figures 1 and 2 were obtained by averaging data for stations at Robeline, Logansport, and Leesville in Louisiana, and at Bronson, Texas. The precipitation records for Robeline and Logansport are fairly complete for the entire period 1904 to date, except that the Robeline station was discontinued at the end of the 1957 year. There were a few scattered months of missing record at Leesville during the period 1925-37, but these records are complete from 1938 to date. Monthly precipitation figures for the missing months of record were estimated on the basis of data for

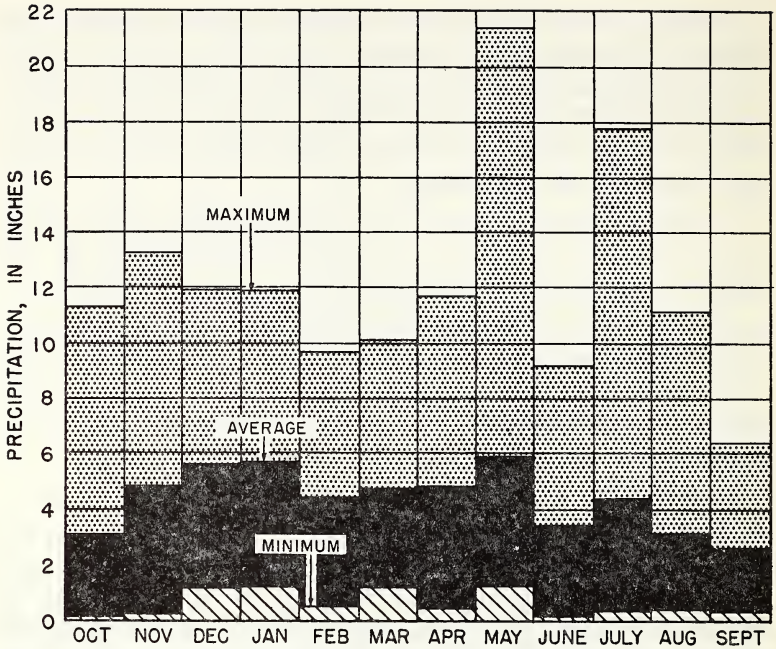


Figure 1. Monthly precipitation in Sabine Parish, La., 1925-58.

other nearby weather stations to compute average monthly precipitation over the parish for the period 1925-58.

Precipitation records since 1925 (fig. 1) show a monthly variation, rainfall being at a maximum in May and at a minimum in the fall months. Most of the summer rain falls in short, torrential local storms that cause considerable erosion and intense runoff. Only rarely does precipitation occur as hail, sleet, or snow. Precipitation records since 1938 show a year to year variation as indicated in figure 2. The variation in annual precipitation at Robeline in the period 1897-1957 shown in figure 3 indicates a larger proportion of dry periods prior to 1938 than occurred after 1938 when complete records were available for all four stations in the area surrounding the parish. At the Robeline weather station the average annual precipitation for the period 1897-1957 was 50.22 inches.

Maximum, minimum, and average monthly air temperature plotted on figure 4 show that the highest average

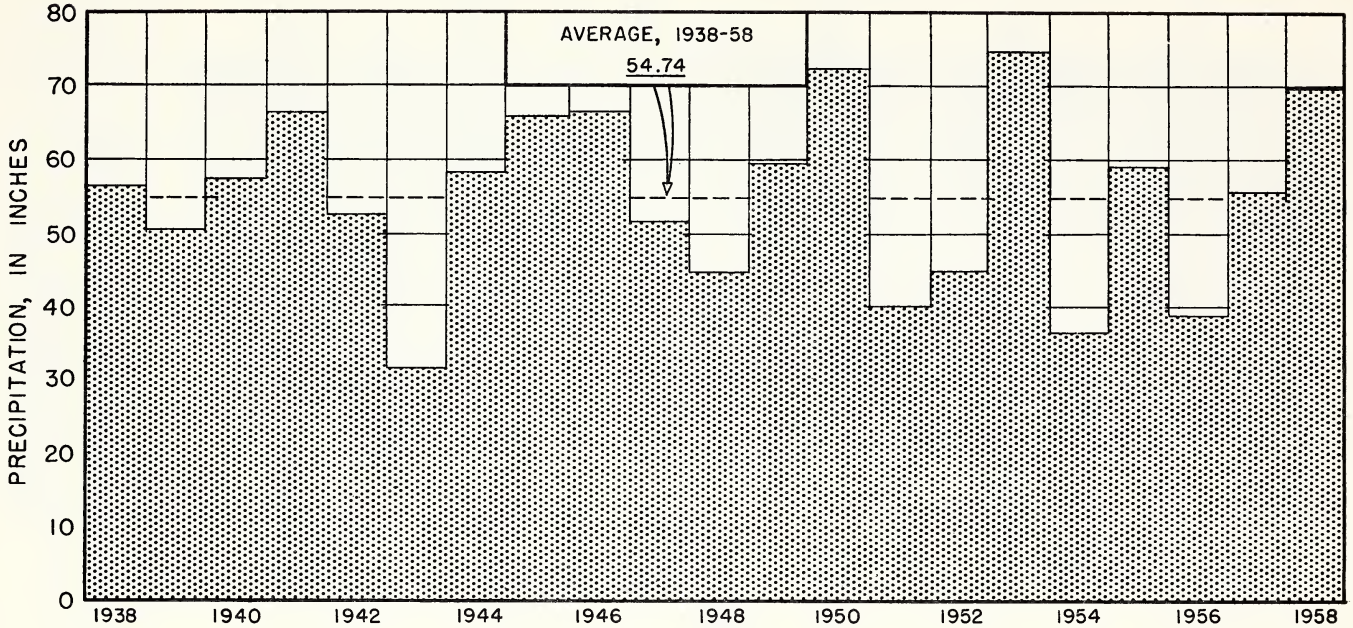


Figure 2. Annual (water year) precipitation in Sabine Parish, La., 1938-58.

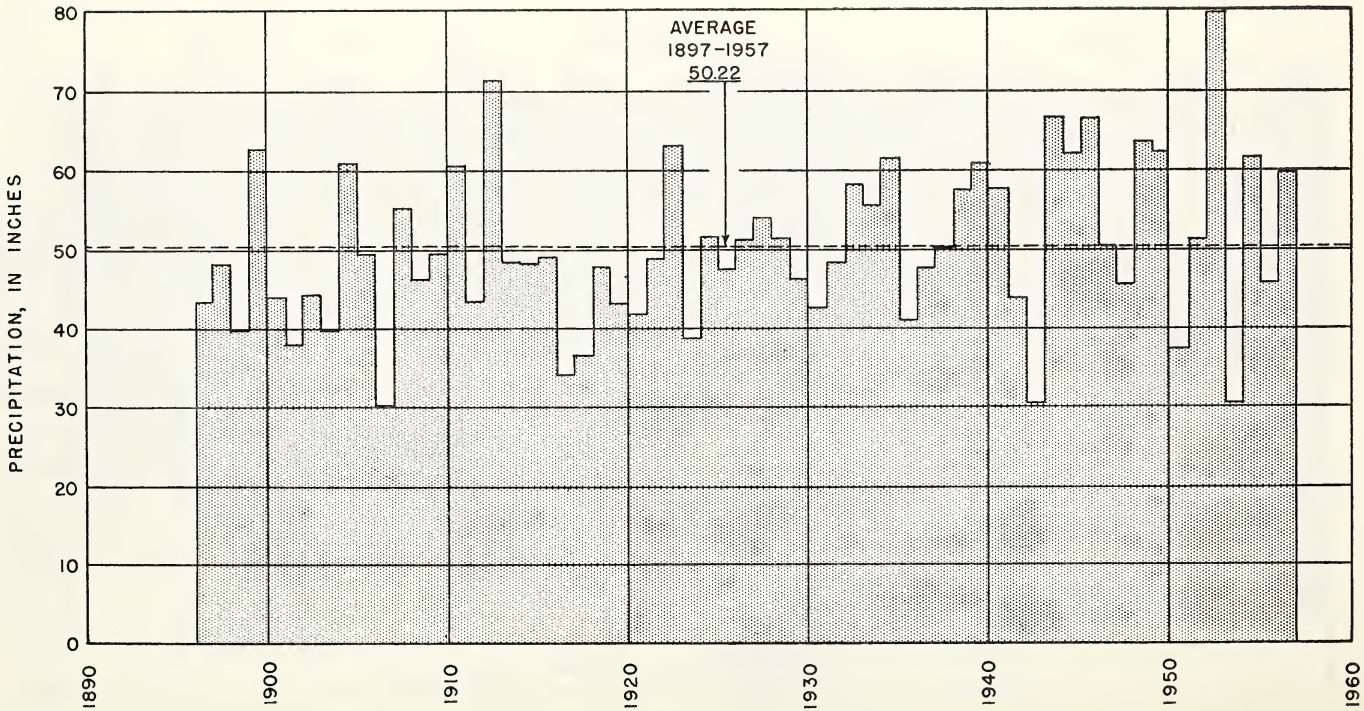


Figure 3. Annual precipitation at Robeline, La., 1897-1957.

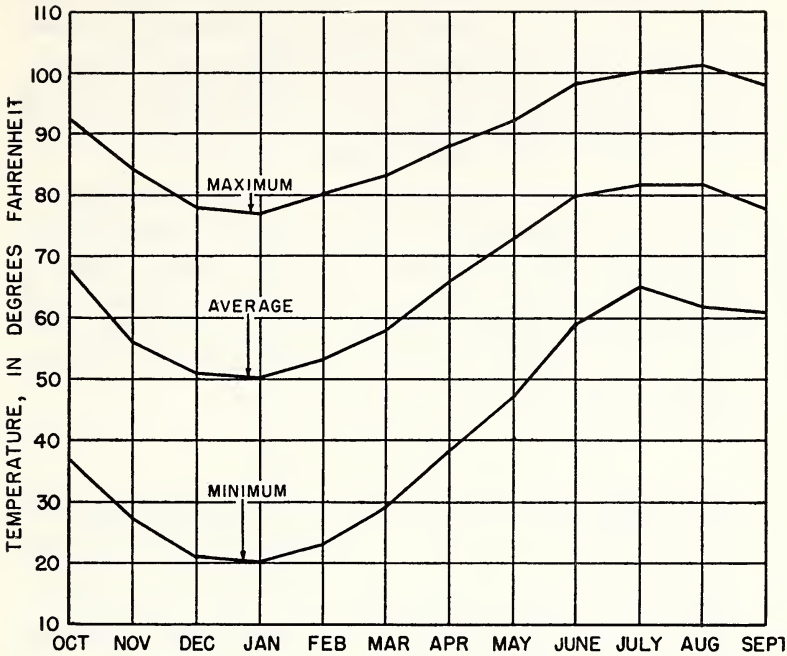


Figure 4. Summary of monthly air temperature in Sabine Parish, La., 1925-58.

monthly air temperature occurs in July or August and the lowest in December and January. The annual average of maximum daily air temperatures is 89°F. The maximum range in the extremes of monthly temperature throughout the year is about 81°F.

Sabine Parish has a growing season of about 230 days between late March and early November, the general limits of the last and first killing frosts. The climate is favorable for widely diversified agriculture, including dairying and stock raising. The length of the frost-free season allows two or more crops to be grown each year.

Agriculture and Natural Resources

Nearly one-fourth of the area of Sabine Parish is devoted to agriculture. The prinicipal products are cotton, livestock, and farm timber. About 85 percent of the land is in commercial forests, and the parish is second only to Winn Parish in the production of saw timber.

Smies, and others (1922, p. 23) listed the following soils and their percentage of distribution in the parish: Susquehanna very fine loam, 41.4 percent; Ruston very fine sandy loam, 4.7 percent; Ochlockonne very fine sandy loam, 4.3 percent; Susquehanna fine sandy loam, 4.0 percent; and 23 other soil types totaling 45.6 percent.

About 1,000 oil and gas wells have been drilled in the parish fields. The cumulative oil and condensate production from six fields, Blue Lake, Converse, Many, Pleasant Hill, Zwolle, and Kilgore Slough, in Sabine Parish was 21.5 million barrels since the fields' discovery through 1957. During the same period, natural gas production was 1,685,-380 million cubic feet from oil and gas wells.

Development of Area

The 1960 census shows the population of Sabine Parish as 18,356, a decrease of 12.1 percent since 1950. In the same period, the population of Many, the parish seat, increased from 1,681 to 3,155 (87.8 percent). The 1960 census shows the population of incorporated towns of Zwolle, Pleasant Hill, Converse, and Noble to be 1,320, 907, 291, and 206, respectively. The remainder of the parish was rural farm. Except for Many, the parish seat, Sabine Parish is classified as rural, as by definition urban areas are those cities, towns, or villages having 2,500 or more inhabitants.

The parish is served by two main highways which intersect at Many, north-south U.S. Highway 171 connects the parish with Shreveport and Mansfield to the north and Leesville, DeRidder, and Lake Charles to the south. State Highway 6, the old Camino Real, traverses the parish in an east-west direction, and links the parish with Texas towns to the west and with Natchitoches and other towns to the east.

PREVIOUS INVESTIGATIONS

Results of the regular stream-gaging program, carried on for a number of years by the U.S. Geological Survey, published in water-supply papers, were available for this study. The Sabine Parish area in whole or in part has been the subject of several geological and paleontological reports.

Hilgard (1873) described the geology of rocks of Tertiary age in central and northern Louisiana.

The first geologic map of the State, prepared by F. V. Hopkins, was published by the Louisiana Geological Survey in 1872. Reports by Murray and Thomas (1945) and Murray (1955) contain bibliographies listing more recent studies in this and other areas that include rocks of the same age. Murray (1948) described the formations of the Midway stage that underlie and crop out in the northern part of the parish. Welch (1942) delineates the Jackson, Vicksburg, and Catahoula Formations which crop out in the southern part of the parish, and Huner (1939) describes the Claiborne Group which crops out in the central part. The most comprehensive geological report on the parish is that of Andersen (1960) which was published by the Louisiana Geological Survey. This report contains a surface geological map of the parish and has an excellent section on the subsurface geology.

The first ground-water report containing a reference to Sabine Parish was written by G. D. Harris in 1902. It was a brief reconnaissance report covering the entire State. A more comprehensive investigation yielded a report by Veatch (1906a, 1906b) on ground-water resources of northern Louisiana. This bulletin contains data on wells at East Pendleton, Loring, Many, Myricks Ferry, Negreet, Noble, Pleasant Hill, Plymouth, and Zwolle, and maps showing the depths to the different aquifers and the area in which flowing wells might be expected. The Natchitoches report of Maher and Jones (1949) has valuable information on the Claiborne Group and the use of electrical logs.

ACKNOWLEDGMENTS

Acknowledgment is made of the aid furnished by the agencies cooperating with the U. S. Geological Survey in the continuing program of surface, ground, and quality of water investigation. Drillers' logs and electrical logs, well-construction data, and formation samples were supplied by: Miller Drilling Company, Many, La.; B. F. Edington Drilling Co., Shreveport, La.; Jacobs Drilling Co., Many, La.; Rex Water Well Service, Natchitoches, La.; and Mr. H. A.

Davidson, Many, La. Drillers' logs of oil wells were made available by Mr. Richard Cole of the Ohio Oil Co., Shreveport, La. Mr. W. H. Pearce, Jr., Water Superintendent, Many, and Mr. M. J. McFerrin, Water Superintendent, Zwolle, gave freely of their time and assistance during the testing of their towns' wells.

A geologic map compiled by Andersen (1960), Louisiana Geological Survey, was used for checking the authors' determinations of formations cropping out at well locations. Burdge Irelan and S. F. Kapustka assisted in the preparation of the sections of this report that deal with chemical quality of surface water.

OCCURRENCE AND GENERAL PROPERTIES OF WATER

SOURCES OF WATER

Precipitation is the source of practically all fresh-water supply. The principal sources of present water supply in Sabine Parish are wells, the Sabine River, and rainwater catchment in cisterns and farm ponds.

Measurements of flow indicate that of the approximately 52 inches of average annual precipitation over Sabine Parish during the standard 30-year period, about 18 inches runs off in a network of small streams and bayous that eventually flow into Sabine River or Red River. The remainder is lost to evapotranspiration or infiltrates to the ground water zone. The two diagrams in figures 5 and

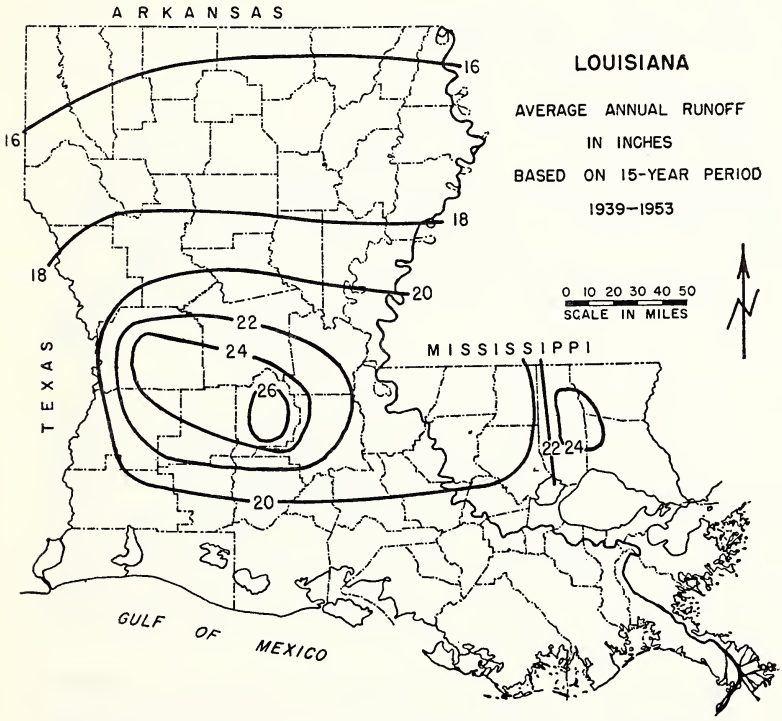


Figure 5. Areal variation in average runoff in Louisiana.

6 illustrate the areal variation in the average annual runoff and precipitation over the entire State. The isograms

on figure 5 connect points of equal runoff based on streamflow records collected over a 15-year period, 1939-53. Lines of equal rainfall, called isohyetals, computed on basis of the standard 30-year period (1921-50) averages, are shown on figure 6.

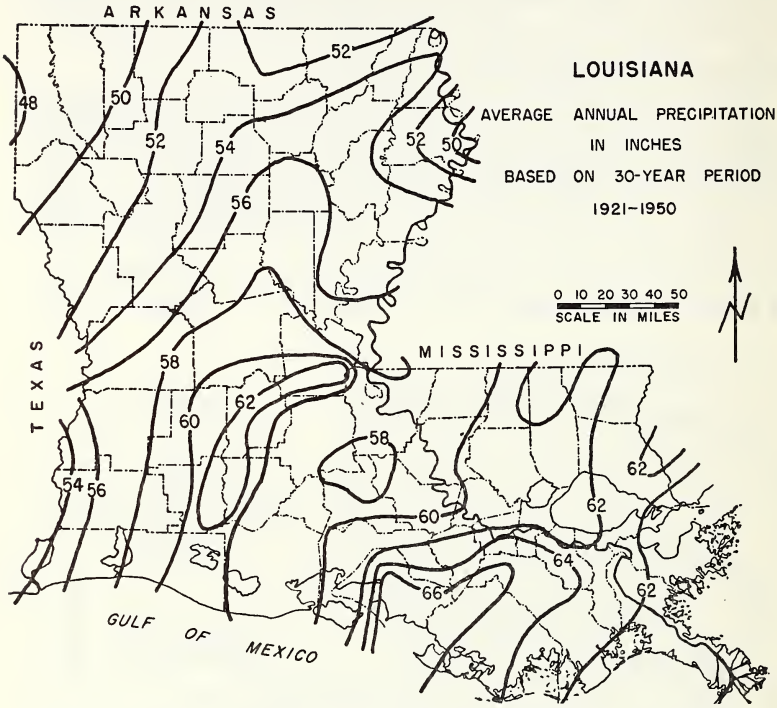


Figure 6. Areal variation in average precipitation in Louisiana.

Sabine River, which flows along the entire western boundary, is the largest surface supply available to the parish. It carries the runoff from approximately 7,000 square miles. The streams that drain the upland areas are of limited importance as dependable sources of supply because their flows are not well sustained during dry seasons. However, with development of artificial storage many are potential sources of potable supply.

Potable ground water occurs in moderate quantity throughout the parish and is used as a source of supply for the towns of Many, Pleasant Hill, and Zwolle. Its occurrence and the related geology are discussed in detail in another section of this report.

SIGNIFICANCE OF THE CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER

No single group of standards meets all chemical, physical, or sanitary requirements for the varied uses of water. Water that meets the requirements of one user may be unsatisfactory for another. Water uses may be divided into three broad classes—agricultural, domestic, and industrial.

The type and the characteristics of the dissolved solids are essential considerations for water that is used for irrigation, which is the main agricultural use. Although hardness of water as well as iron, manganese, fluoride, sulfate, nitrate, and other constitutents are important, the domestic consumer is primarily concerned with bacterial and sanitary characteristics. The dissolved-solids content, hardness, alkalinity, hydrogen-ion concentration, organic and inorganic impurities, color, corrosiveness, and temperature are primary factors in determining the value of water for industrial use.

Four major characteristics determine quality of water for irrigation: dissolved solids; the sodium content and the proportion of sodium to calcium plus magnesium; the bicarbonate content; and the occurrence of minor elements, such as boron, in amounts that are toxic. Irrigation water with a moderate degree of salinity (having a dissolved-solids content as much as several thousand parts per million) can be used if leaching and drainage are provided to remove dissolved salts that would otherwise accumulate in the root zone or in the subsoil just below. Ground water may contain small amounts of boron. Although limited concentrations are necessary for plant growth, boron content of more than 1 to 3 ppm (parts per million) is injurious to most plants. Recommended limit for sodium in irrigation water is less than 60 percent where percent sodium is equal to $(Na \times 100 \div (Ca+Mg+Na+K)$ and these elements are expressed in terms of milliequivalents per liter (Wilcox, 1948).

The U.S. Salinity Laboratory (1954, p. 80) diagram for classifying waters for irrigation divides water into four classes with respect to sodium hazard, the dividing points being at SAR (sodium-adsorption ratio) values of 10, 18, and 26. They range from low-sodium water that can be

used for irrigation on almost all soils to very high-sodium water, which is generally unsatisfactory for irrigation. SAR provides an estimate of the sodium or alkali hazard and reportedly is more significant for interpreting water quality than percent sodium because its relates more directly to the exchangeable sodium percentage the soil will attain when it and the water are in equilibrium.

Maximum recommended concentration limits for some of the chemical constituents commonly found in water have been established by the U.S. Public Health Service (1962). These standards, which apply to drinking water used in interstate traffic and where Federal Quarantine Regulations apply, are as follows:

Iron (Fe)	0.3
Manganese (Mn)	.05
Magnesium (Mg)	125
Sulfate (SO_4)	250
Chloride (Cl)	250
Fluoride (F)	* 1.8
Nitrate (NO_3)	45
Dissolved solids	500

Iron and manganese in concentrations of more than a few tenths of a part per million are objectionable for domestic purposes because they stain porcelain, enamel, clothing, and other fabrics. Although iron in solution seldom occurs in surface water in sufficient quantity to cause harm, it often is present in ground water and precipitates as a rust-colored deposit of ferric hydroxide during oxidation.

Fluoride concentrations that exceed 1.5 ppm in drinking water may cause mottled tooth enamel in young children during calcification of the teeth (Dean, 1936). However, studies indicate that fluoride lessens the incidence of tooth decay. A fluoride content of 1.0 ppm commonly is considered by many State and local health agencies to be the optimum concentration that will inhibit tooth decay and produce no mottling.

Hardness is the property of water generally attributable to alkaline earths. Calcium and magnesium are the principal alkaline earths, and strontium and barium usually are found in lesser amounts. Iron, manganese, aluminum,

*For Sabine Parish only.

and free mineral acid also cause hardness, but they generally are not present in such quantities as to cause appreciable hardness. Hardness is an indication of the soap-consuming power of the water and is recognized by the curd formed with soap. Hardness of water to be used for ordinary household purposes does not become particularly objectionable until it reaches the level of 100 ppm or so. Above a level of 200 ppm hardness is decidedly noticeable and becomes increasingly troublesome as the concentration rises.

Carbonate or temporary hardness includes that part of the hardness equivalent to the carbonate and bicarbonate present in the water. Any hardness in excess of this amount is called non-carbonate, or permanent hardness. Carbonate hardness is removed by boiling whereby the calcium and magnesium corresponding to the equivalent of carbonate and bicarbonate are precipitated in the form of calcium and magnesium carbonate. The use of hard water causes objectionable scale in boilers, water heaters, radiators, and pipes, and reduction in flow and heat transfer, and may cause boiler failure.

Industry is more concerned with quality of water than with quantity, for it may cost more to treat the water than to develop the original supply. Uniformity in quality of the water is usually as necessary as special chemical characteristics. General requirements of water quality for various types of industry are given in table 1.

Turbidity of water due to suspended material such as silt, clay, finely divided organic material, microscopic organisms, and similar materials, is objectionable in many ways. Besides the sanitary objections and muddy appearance, turbidity may cause costly repairs due to the abrasive action on pumps, turbines, blades, and valves.

Color in water is due to dissolved substances of animal, vegetable, or mineral origin. The yellow-to-brown color of some water may be caused by organic matter extracted from leaves, roots, and other organic substances on the ground. In some areas objectionable color in water may result from industrial wastes and sewage. Some substances causing high color may cause foaming in boilers and hinder treat-

ment involving precipitation, such as iron removal and hot phosphate softening.

Color in water is disadvantageous in many enterprises, such as ice-making, beverages, photographic, laundry, and textile industries. Color is expressed in units of the platinum-cobalt scale proposed by Hazen (1892). A color less than 10 units usually passes unnoticed. Some swamp waters have natural color of more than 200 to 300 units.

Iron and manganese are objectionable in water and unless removed may cause staining of laundry and plumbing fixtures. Iron is objectionable to the taste if in concentrations higher than about 0.5-1.0 ppm. Concentrations of more than 0.5 ppm of manganese in water are reported to form objectionable deposits on cooked food, laundry, and plumbing fixtures.

The degree of acidity or alkalinity of water is commonly reported as pH, the negative logarithm of the hydrogen-ion concentration expressed in moles per liter. A pH value of 7.0 indicates neutrality, values lower than 7.0 denote acidity, and values higher than 7.0 denote alkalinity. The pH helps to determine the corrosiveness of water and the amount and type of corrective treatment.

Expression of Results

One part per million (ppm) is a unit weight of a constituent present in a million unit weights of water. Some laboratories report constituents in grains per gallon but this practice is gradually being superseded by the more convenient expression of parts per million. Results expressed in parts per million can be converted to grains per gallon by multiplying by 0.0584; conversely, grains per gallon can be converted to parts per million by multiplying by 17.

Equivalents per million (epm) expresses concentration in terms of reacting capacity and is the number of unit equivalent reacting weights of an ion in 1 million unit weights of water. An equivalent weight of a substance is the weight that is exactly equal in reacting capacity to one atomic weight (1.0080 grams) of hydrogen. The equivalents per million for each constituent are calculated by dividing

its concentration in parts per million by its equivalent weight. For example, 100 ppm of calcium divided by its equivalent weight (20.04) amounts to 4.99 epm of calcium. Equivalents-per-million data are useful in checking the accuracy and the completeness of analyses. When all major constituents have been determined, the sum of the cation epm should approximate the sum of the anion epm and are useful for expressing analyses graphically.

The weighted average of analyses represents the approximate composition of water that would be found in a reservoir containing all the water passing a given station during the year, after thorough mixing in the reservoir.

SURFACE-WATER RESOURCES

By Leland V. Page

QUANTITATIVE DATA AND ANALYTICAL STUDIES

Several streams that flow in, near, or through the parish are potential sources of water supply for the parish. Available streamflow records that include stations on Sabine River, Bayou San Patricio, Bayou San Miguel, Bayou La Nana, and Bayou Toro (pl. 8 and fig. 7) are compiled and analyzed. A brief description of each stream-gaging station, accompanied by tables of monthly discharge, monthly runoff, and yearly discharge is given in tables 14-20.

If streams in the area are to be used as the source of large additional supplies, water must be held in storage for several months or even several years. The approximate amount of storage required for specific rates of withdrawal can be computed from the tabulations of monthly discharge. These monthly discharges summarize the daily discharge published annually in the U.S. Geological Survey water-supply papers as parts 7 and 8 of the series "Surface Water Supply of the United States." Similar summaries through the water year 1950 are published in Water-Supply Papers 1311 and 1312, and summaries for the water years 1951-60 are planned for publication by the Federal Survey.

The basic surface-water data used in this report have been collected by the U.S. Geological Survey in cooperation with agencies of the State of Louisiana and with the Texas State Board of Water Engineers. A great part of the data available for this report was obtained by investigations carried on by the U.S. Geological Survey in cooperation with the Louisiana Department of Public Works. At several locations flood-flow data were obtained by the Survey in cooperation with the Louisiana Department of Highways. Other data and information have been taken directly from technical reports of the U.S. Weather Bureau and the Louisiana Department of Public Works.

Explanation of Hydrologic Terms

Quantities of water, as presented in records shown in this report, are in units of cubic feet per second (cfs), run-

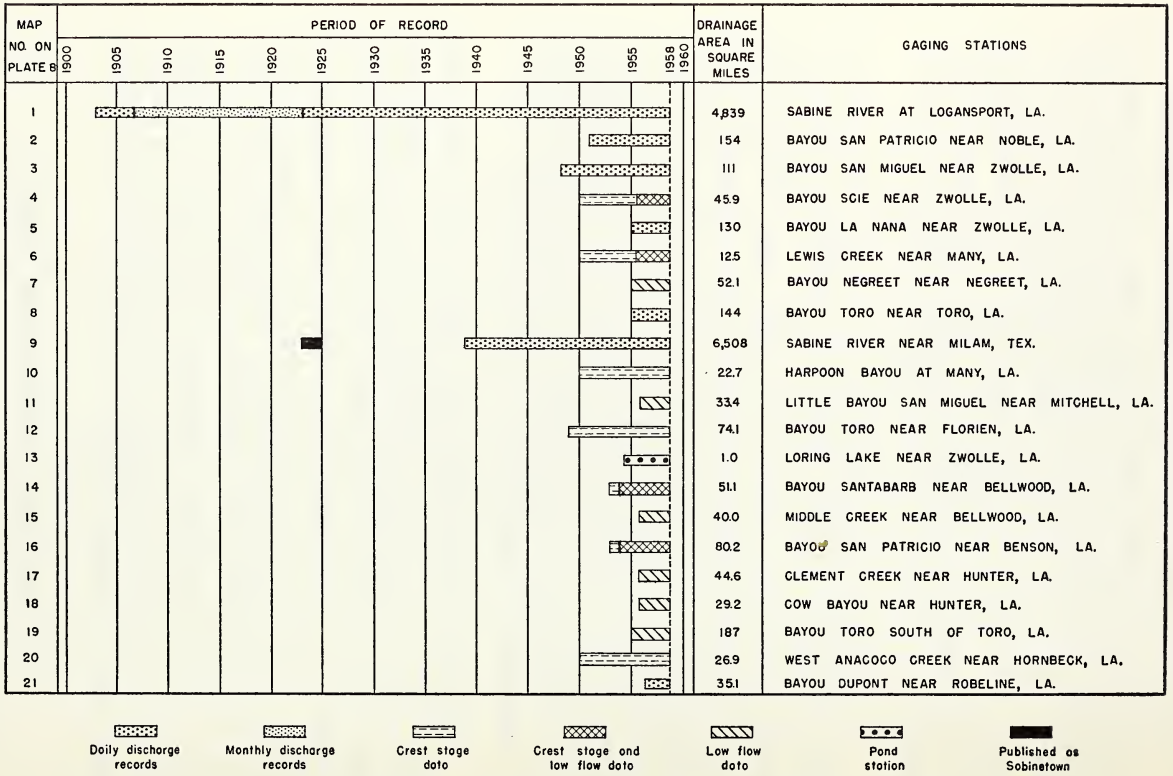


Figure 7. Bargraph showing length of gaging-station records.

off in inches, and runoff in acre-feet. Second-feet was formerly used in U.S. Geological Survey reports as an abbreviation of cubic feet per second.

A cubic foot per second (cfs) is the rate of discharge equivalent to that of a stream whose channel is 1 square foot in cross-sectional area and whose average velocity is 1 foot per second.

Cubic feet per second per square mile is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the runoff is distributed uniformly as regards time and area.

Runoff in inches is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface.

An *acre-foot* is equivalent to 43,560 cubic feet and is the quantity of water required to cover an acre to the depth of 1 foot.

1 cfs = 449 gpm (gallons per minute).
1 cfs = 646,317 gpd (gallons per day).
1 acre-foot per day = 0.504 cfs, or 1 acre-foot = 504 cfs-days, or 0.504 cfs for 24 hours (1 day) = 1 acre-foot.

Streamflow Characteristics

Variations in the topography and geology over an area are evident in the behavior of streams draining the area. Difference of topography and geology in adjoining drainage areas cause significant differences in runoff from the areas.

Some areas have a permeable soil cover and underlying rocks with a large capacity for penetration and storage of ground water, which is later released to the streams at a relatively steady rate. Consequently, the streamflow will be well sustained during the fair weather periods. On the other hand, in areas with a shallow soil cover over impermeable rocks or poorly drained subsoils, streamflow will recede rapidly from sharply concentrated flood peaks to low flow,

or even no flow. Ground-water storage and timing factors, however, generally have only a slight influence on the total volume of runoff.

The behavior of the streamflow with respect to the time it takes the runoff from a storm to be discharged from a basin is illustrated in figure 8. Figure 8 is a hydrograph

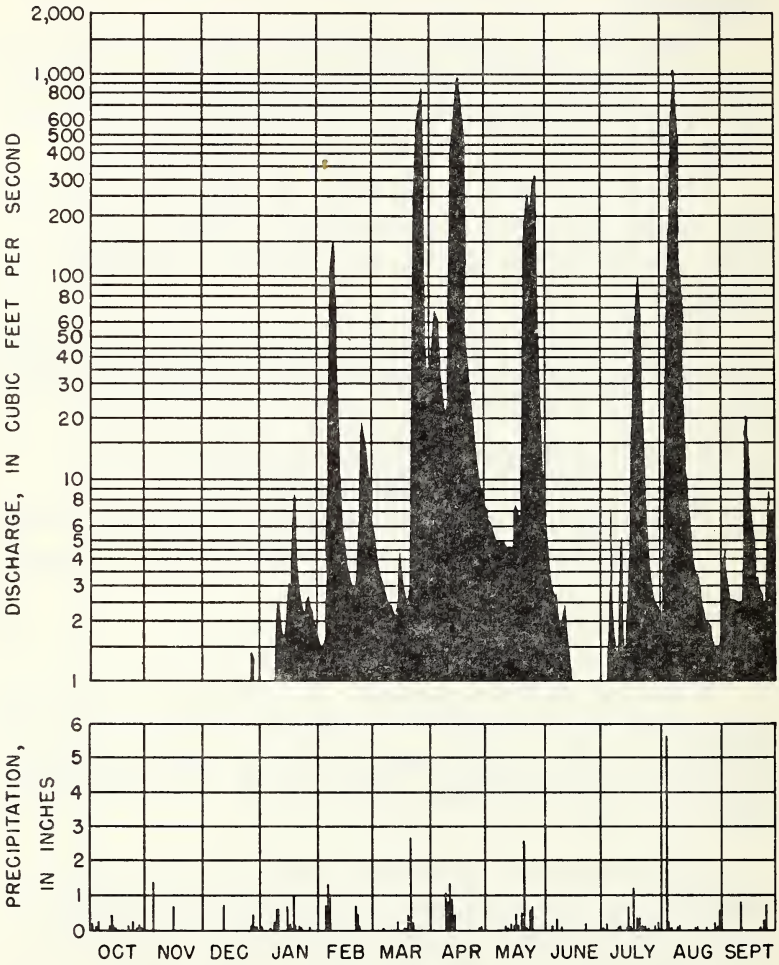


Figure 8. Hydrograph of daily discharge of Bayou San Patricio near Noble, La. with mean daily precipitation at Mansfield, La. and Converse, La. for water year 1955.

of daily discharge of Bayou San Patricio near Noble, La. with a plot of the corresponding mean of daily rainfall at

Mansfield and Converse for the water year 1955 (flows amounting to less than 1 cfs not shown in this figure). In general there is about a 2-day lag between the time the center of mass of the storm passes over this area and the time the peak discharge occurs at the gaging station at Noble. The stream is moderately flashy, but high flow persists for a considerable period following storms. The persistence of high flow is attributed to the comparatively permeable subsoils in the basin. The soils infiltrate a large part of rainfall and readily yield it to streams as seepage flow. The streamflow regimen for Bayou San Patricio is probably representative of that to be expected from most other streams draining the interior parts of the parish having similar topography and subsoil type.

To facilitate the evaluation and comparison of streamflow characteristics of various streams in or near the report area, records of daily discharge have been analyzed and presented in several different ways. Flow-duration curves (fig. 9) are shown for three streams that are not appreciably affected by regulation—Bayou San Miguel, Bayou San Patricio, and Sabine River. Curves of maximum period of deficient discharge (fig. 10) and storage requirements (fig. 11) are shown for Sabine River. Low-flow frequency curves (figs. 12 and 13) are shown for Sabine River at Logansport and near Milam.

A flow-duration curve shows the cumulative frequency of occurrence of different rates of flow at a given point. It indicates the percent of time, during the period studied, that any given rate of flow was equalled or exceeded. In general, the longer the period of record from which the flow-duration curve data are computed, the more representative of average conditions will be the results.

Flow-duration data in this report are shown in cubic feet per second and in millions of gallons per day. Assuming equal yield from all parts of the drainage area, these data may be used to estimate flow characteristics at any place on the stream. For example, if information is desired on Sabine River at a place where the drainage area is 7,000 square miles, flow-duration data can be estimated by drainage area proportionality from data for Sabine River near

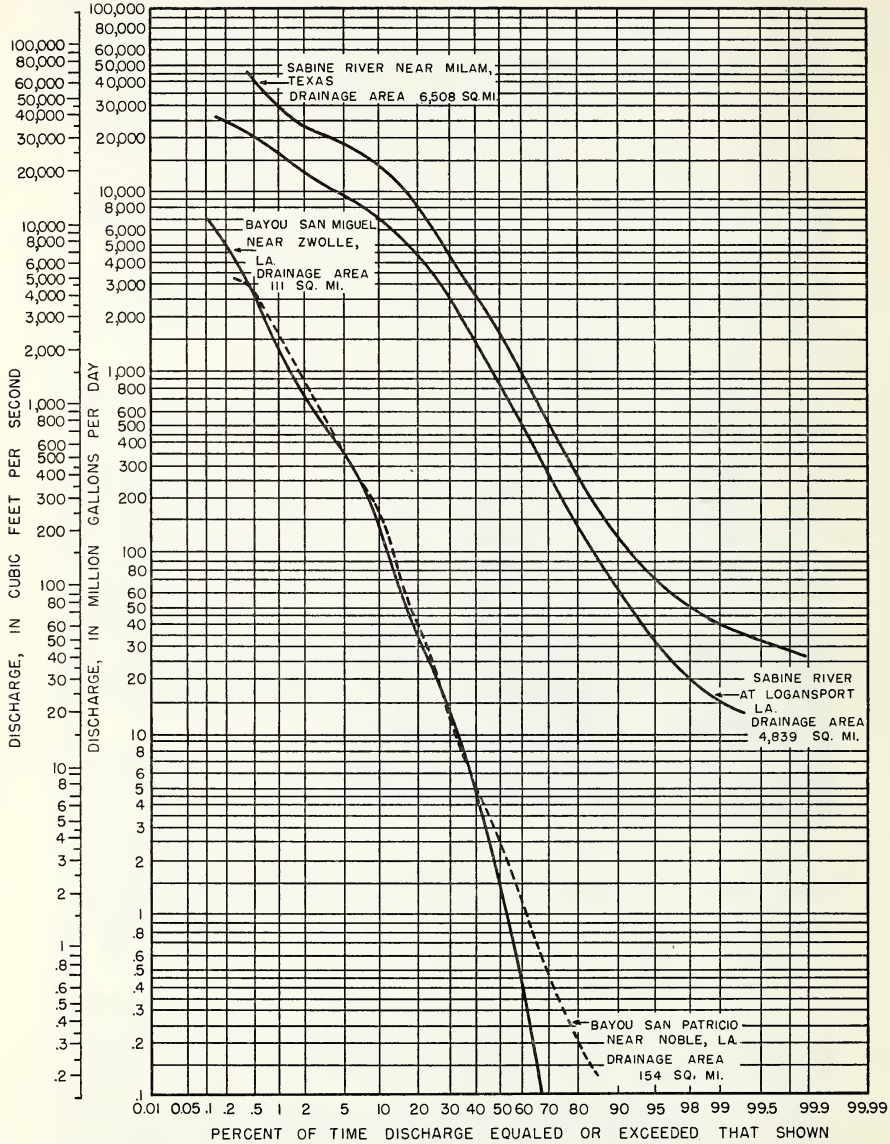


Figure 9. Duration of daily flow of streams in and adjacent to Sabine Parish, La., 1932-55.

Milam which has a drainage area of 6,508 square miles (fig. 9). A daily flow of 1,720 mgd (1,600 mgd times 7,000 ÷6,508) may be expected to be equalled or exceeded 50 percent of the time, and a daily flow of 53.8 mgd (50 mgd times 7,000÷6,508) may be expected to be equalled or exceeded 98 percent of the time. Care should be exercised in using this method, because not all parts of a drainage basin may have equal yields or the same runoff characteristics. In general, the possible error increases with an increase in the distance upstream or downstream from a gaging station.

The flow-duration curve (fig. 9), the curve showing maximum period of deficient discharge (fig. 10), the curve showing storage requirements (fig. 11), and the low-flow

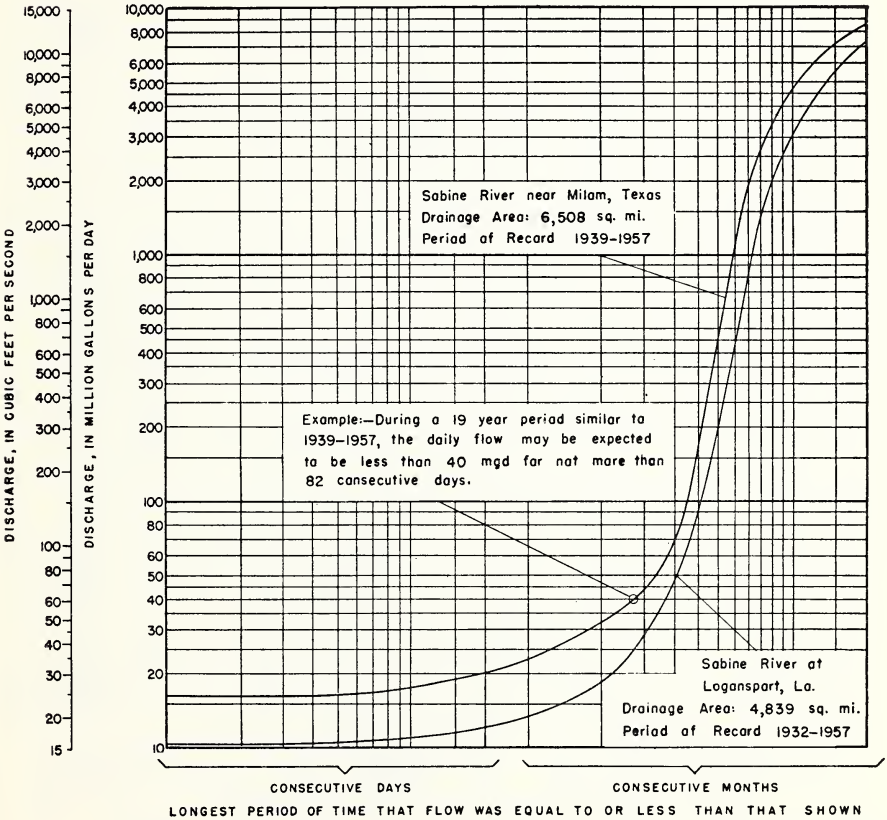


Figure 10. Maximum period of deficient discharge for Sabine River at Logansport, La., and near Milam, Tex.

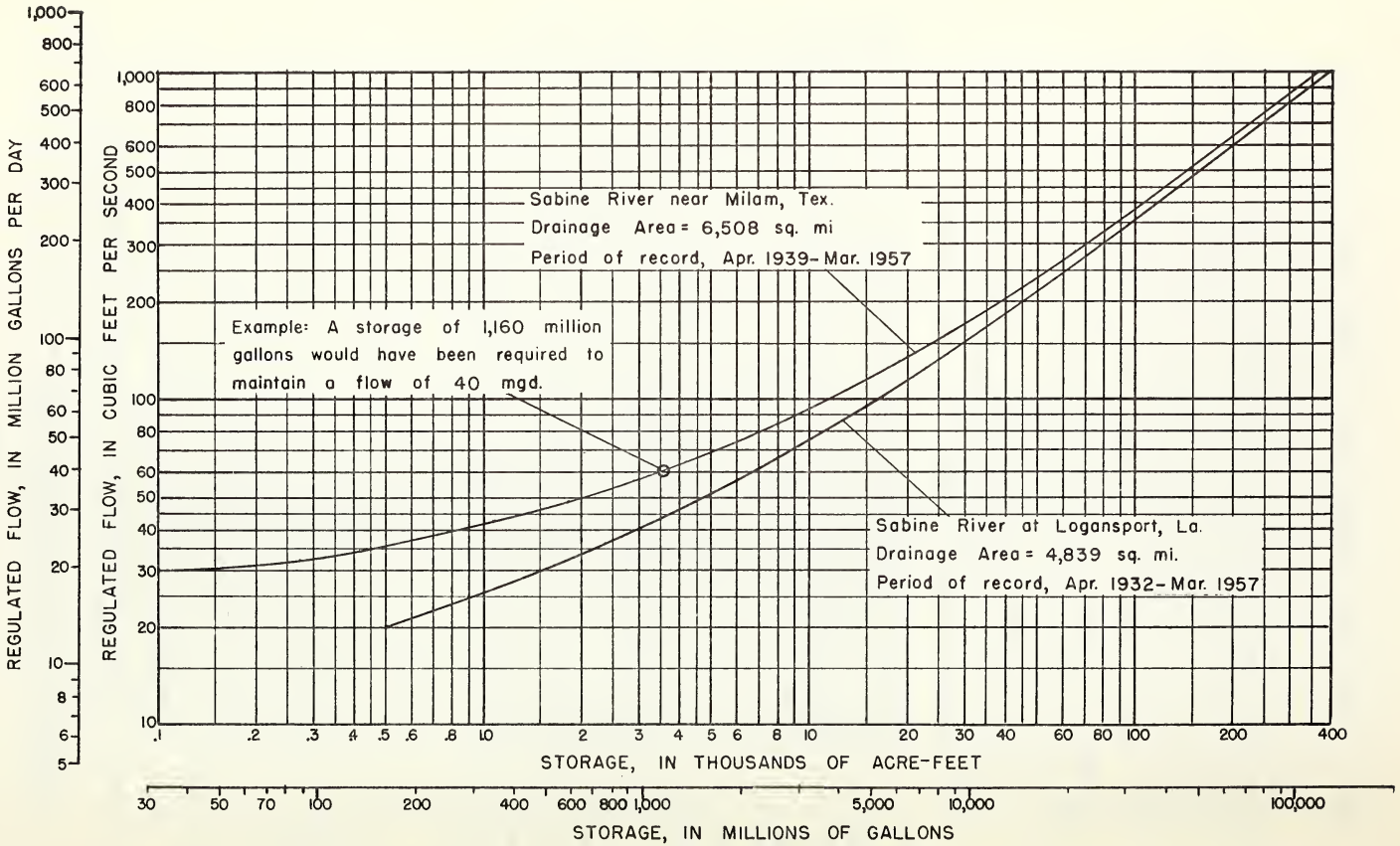


Figure 11. Storage requirements, Sabine River at Logansport, La., and near Milam, Tex.

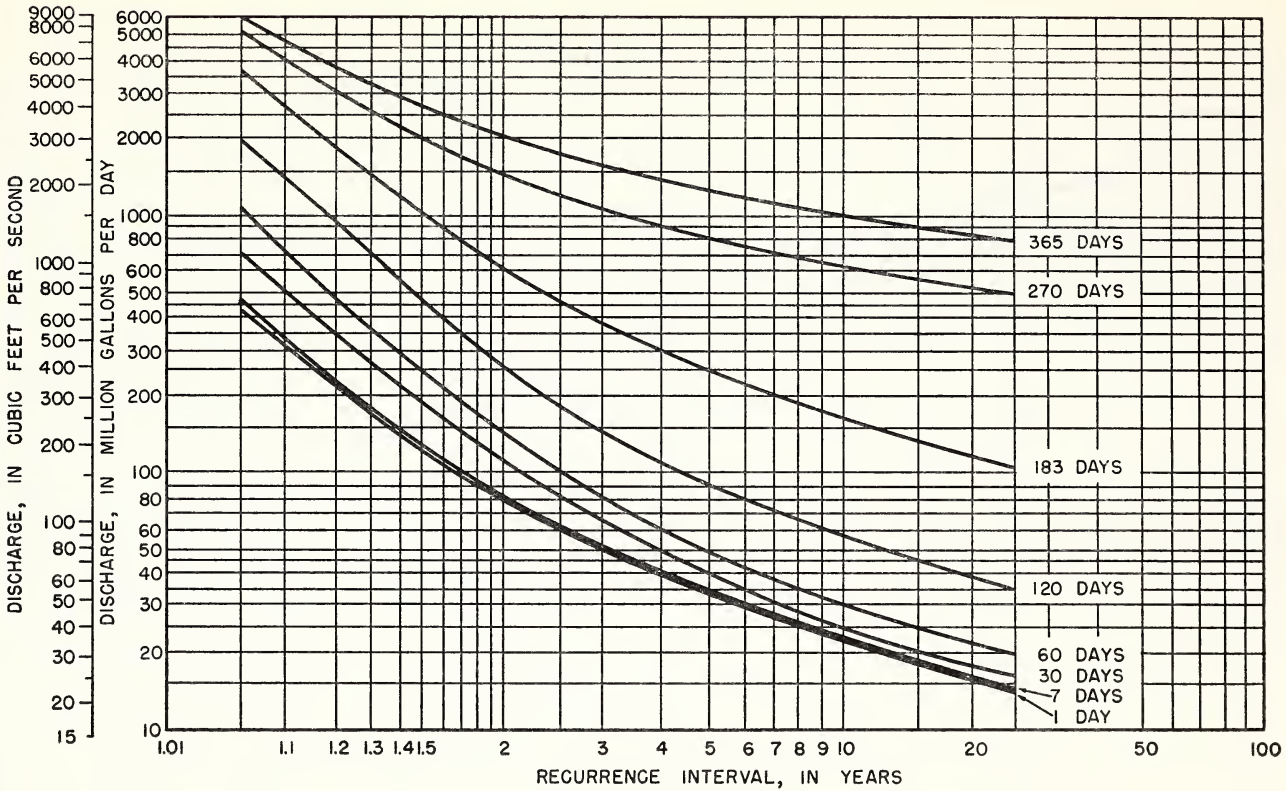


Figure 12. Frequency graph of annual low flow for Sabine River at Logansport, La., 1932-54.

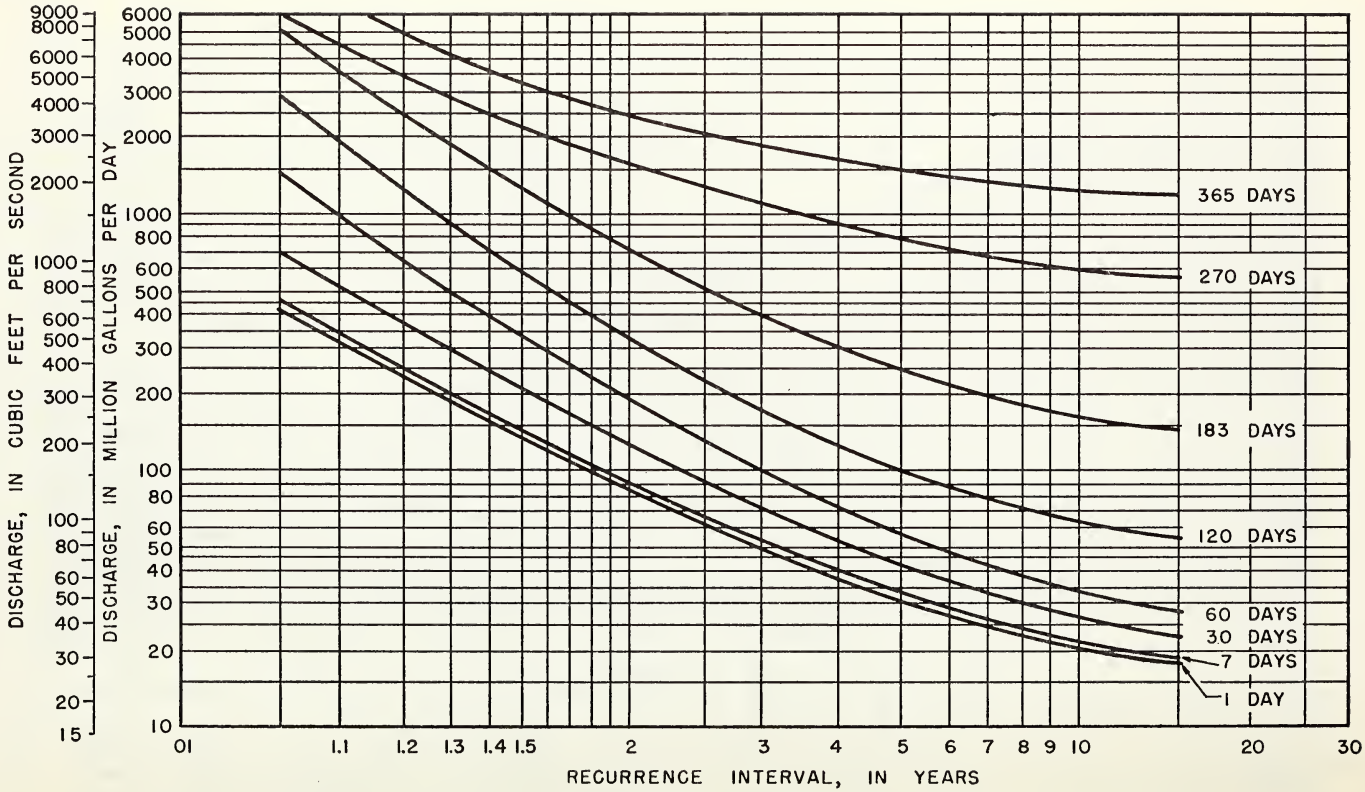


Figure 13. Frequency graph of annual low flow for Sabine River near Milam, Tex., 1939-54.

frequency graphs (figs. 12, 13, and 14) can be very useful in the solution of many water-supply design problems. For example, suppose 40 mgd was required for a hypothetical plant site on Sabine River at Pendleton (near Milam, with a drainage area of 6,508 square miles). If flow conditions in the future are comparable to those experienced during the period 1932-55, 40 mgd would be available from Sabine River 99 percent of the time (fig. 9). During unusually dry years, such as the lowest experienced during the 19-year period 1939-57, the daily flow at Pendleton (near

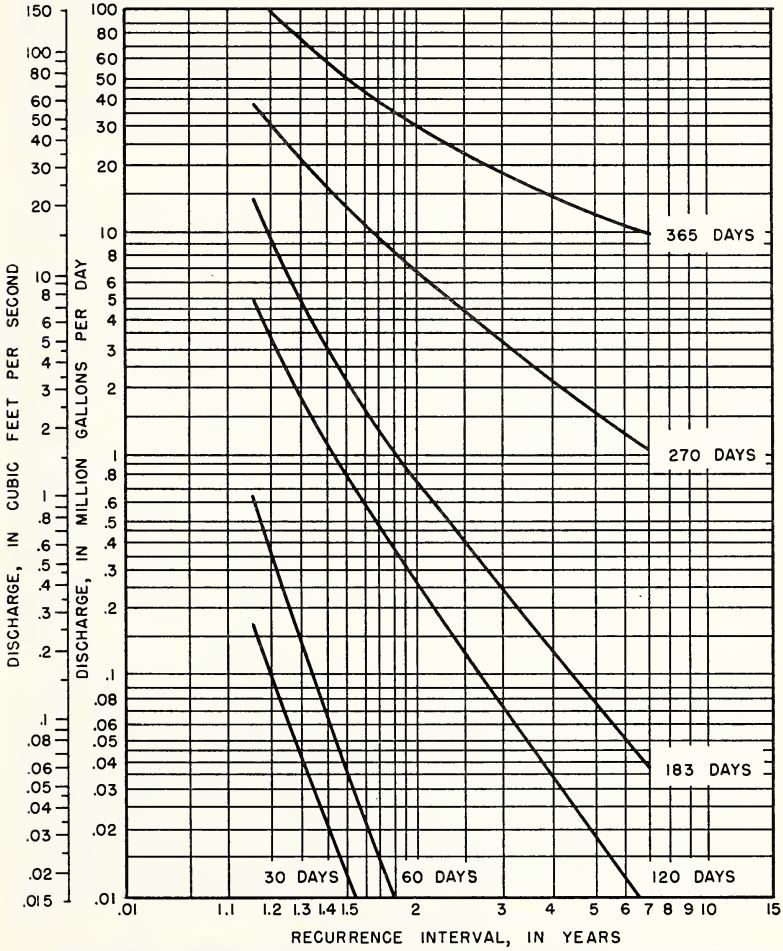


Figure 14. Frequency graph of annual low flow for Bayou San Miguel near Zwolle, La., 1939-54.

Milam) would be expected to be less than 40 mgd for not more than 82 consecutive days (fig. 10).

During the 19-year period a storage of 1,160 million gallons would have been required to maintain a flow of 40 mgd (fig. 11). To this volume must be added the amount of dead storage below the reservoir outlet and an allowance of evaporation and leakage from the reservoir. Without storage, the daily flow would be as low as 40 mgd at average intervals of 3.75 years and the average flow for 30 days would be as low as 40 mgd at average intervals of 5.4 years (fig. 13). This does not mean that a daily flow of as low as 40 mgd would occur at regular intervals of 3.75 years, but that over a long period of time the minimum daily flow during the year would be expected to be as low as 40 mgd about 27 times in 100 years.

The Sabine River Compact between the States of Texas and Louisiana provides in brief; that all free water in the State line reach shall be equally divided between the two States, this division to be made without reference to the origin, that; reservoirs and permits above the State line existing as of January 1, 1953, shall not be liable for maintenance of the flow at the State line, and that; reservoirs on which the construction is commenced after January 1, 1953, above the State line shall be liable for their share of water necessary to provide a minimum flow at the State line of 36 cfs; provided, that no reservoir shall be liable for a greater percentage of this minimum flow than the percentage of the drainage area above the State line contributing to that reservoir, exclusive of the watershed of any reservoir on which construction was started prior to January 1, 1953. Water released from Texas' reservoirs to establish the minimum flow of 36 cfs is classed as free water at the State line and divided equally between the two States. The term "free water" means all waters other than stored waters in the State line reach including, but not limited to, that appearing as natural streamflow and not withdrawn or released from a reservoir for specific uses, and including waters released from reservoirs for the purpose of maintaining streamflows provided in article V and spills or releases of stored waters made in anticipation of spills.

Low Flows

The streams of Sabine Parish were at their lowest during the severe drought periods in the 1943 and 1954 water years. The average annual rainfall for these two drought years was slightly less than 34 inches compared with an average annual rainfall of 54.7 inches for the period 1938-58.

Webster defines a drought as dryness, or want of rain. Actually a drought can occur immediately following rain as it is, in effect, a deficiency of water. The use to which the water is put, the required amount needed for plant growth and animal life, and the control exercised over the supply of water, among many other factors influence the seriousness of the shortages in drought periods. In many regions agricultural droughts in varying intensities occur nearly every year and can be caused by deficiencies of rainfall for very short periods of time.

Thornthwaite and Mather (1953) have stated, "Drought does not begin when rain ceases but rather only when plant roots can no longer obtain moisture in needed amounts. To farmers everywhere drought is a serious matter. Drought is hard to measure because we are not yet able to determine the water needs of plants very accurately. We do not know when to expect droughts or how intense they may be. Therefore, we can not be sure which moisture-conservation measures may be best at a given time and place. Droughts deserve study. Not until we have conquered drought by scientific irrigation will we achieve the maximum production from the soil."

The availability of water and the magnitude and frequency of low flows become important factors in the future water-resources development within a given area. As previously mentioned, the low-flow frequency graph is a valuable tool in the planning stages of a municipal water supply, an industrial or power plant development, supplies for irrigation, pollution control, or for any other specific purpose.

Low-flow frequency graphs based on annual flows for the climatic years starting April 1 for Sabine River at

Logansport, La., and Milam, Tex., and Bayou San Miguel near Zwolle are given in figures 12, 13, and 14. The curves show the recurrence interval or probable return period for low flows of several durations. Sabine River drains areas of higher sustained flow than do the streams within the parish such as Bayou San Miguel and Bayou San Patricio. A low-flow frequency graph was not drawn for Bayou San Patricio owing to the short period of record available. Low-flow frequency curves for flows of 7 days, 10 days, and 20 days could not be depicted clearly and were not shown for Bayou San Miguel near Zwolle as they nearly coincide with the curve for 30 days. The low-flow frequency graph for Sabine River at Logansport, for example, shows that an average flow as low as 24 mgd can be expected for a period as long as 1 month with a recurrence interval of 10 years.

Additional data on low-flow characteristics in the form of low-flow measurements on some of the streams within the parish not having regular gaging stations have been obtained periodically since 1954. The data from these measurements are too sparse at this time to make any reliable correlations with records for the regular gaging stations. A more dependable estimate of a stream's characteristics can be ascertained, however, with several measurements than with none at all. These measurements are listed in table 2. Several streams are known to go dry and remain so for weeks every year but others have sustained flow 100 percent of the time. Table 2 shows the discharge for Bayou Toro south of Toro to be quite high compared with the discharges for Bayou San Miguel near Zwolle and Bayou San Patricio at corresponding times. A flow of 9.2 cfs measured for Bayou Toro south of Toro during the drought season of 1955 is indicative of high sustained flow and a potentially dependable source of supply. The length of time the streams remain dry depends on the size of the drainage area, geology, length of time without rainfall, and sustenance of flow from ground-water supply. It is planned to continue a well balanced low-flow program until sufficient data are available to make reliable correlations with records at regular gaging stations.

Floods

The flood of April 8, 1945, the maximum known and recorded on the Sabine River, reached an elevation of 191.79 feet above mean sea level at Logansport. The second highest known flood, that of May 1884, reached a stage of 39.4 feet (present datum), or an elevation of 187.1 feet above mean sea level, at the Logansport gage. The flood of May 1915 and the flood of 1921 rank second and third, respectively, in magnitude for the period of record at Logansport, which dates back to 1903. The more recent flood of May 1953 ranks fifth in magnitude and frequency in the same period of record.

Maximum stage recorded on Bayou San Miguel occurred on April 30, 1950, producing a flow of 15,000 cfs near Zwolle. The flood of April 30, 1953, is the highest of record for Bayou San Patricio. These two floods were caused by torrential rains in the headwaters of the streams. The storm of April-May 1953 produced high stages on practically all the streams in and adjacent to the parish.

Lists of annual maximum stages and discharges for Sabine River at Logansport, La. and Milam, Tex. appear in tables 3 and 4 respectively. Water-surface profiles for the floods of April 1945, February 1950, and May 1953 on the Sabine River from Gladewater to Ruliff, Tex. are shown on figure 15.

Highest annual stages on Sabine River near Milam, Tex. in the 17-year period 1939 to 1955, occurred in every month except August, September, October, and December. The largest percentage of occurrence in any one month is 24 percent in February. The highest annual stages occurred in April and May in 46 percent of the years on the Sabine River at Logansport, La., in the 52-year period 1903-1955. Figure 16 shows the distribution of the annual floods with respect to the month of the year.

The probable frequency of floods is an important factor in any project involving flood control and protection or in the proper design and location of structures placed in, across, or adjacent to streams. Levees, dams, or similar structures that may cause loss of life in the event of failure

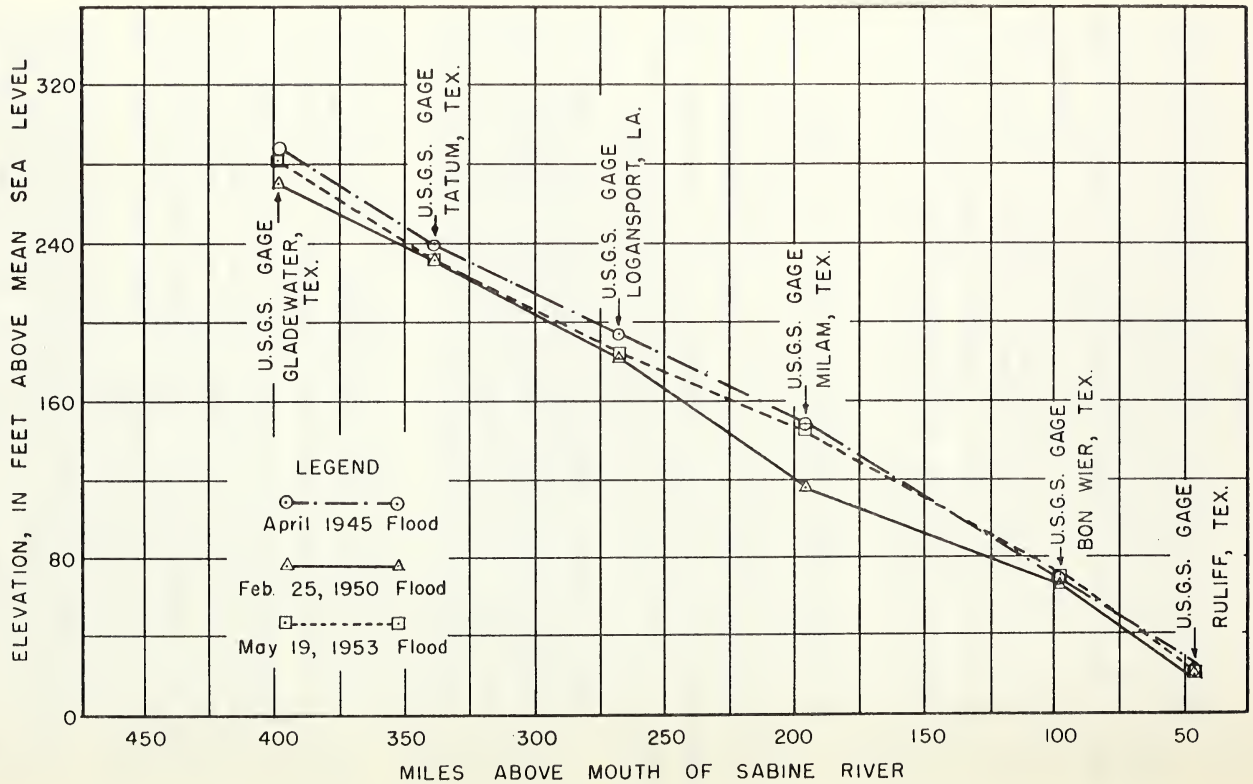


Figure 15. Water surface profiles for selected floods on Sabine River, Gladewater to Ruliff, Tex.

are usually designed to withstand the maximum probable flood. Works of lesser importance, however, where failure would not cause a loss of life or would not cause an exceedingly great financial loss may be designed for much lesser floods at considerable savings. Consequently, the more economical approach in such cases may be to design for a

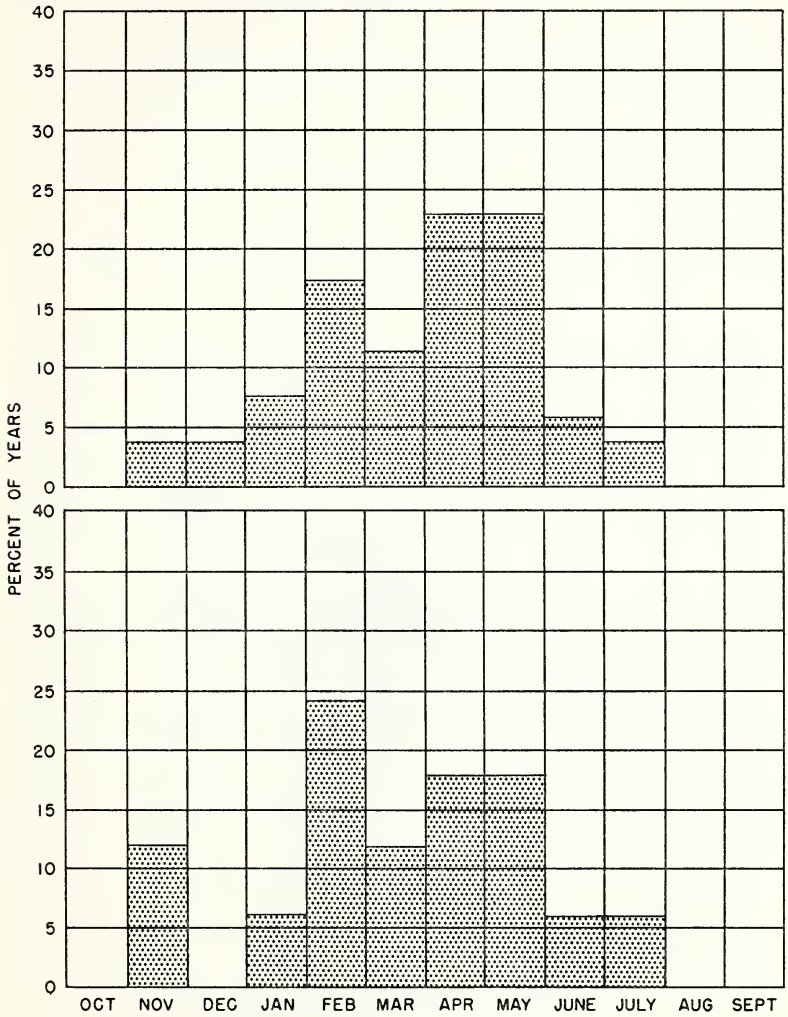


Figure 16. Month of occurrence of annual floods on Sabine River at (A) Logansport, La., 1903-55 and (B) Milam, Tex., 1939-55.

flood of some particular recurrence interval rather than for the maximum probable flood.

The Louisiana Department of Highways published a cooperative report (Cragwall, 1952, p. 229-273) that will aid in the design of waterway openings. This report contains considerable data on Louisiana streams and includes a section on frequency of floods. Figures 17 and 18 were developed from Cragwall's curves for northwestern Louisiana. Figure 17 may be used to estimate the probable magnitude of floods with a recurrence interval of 2.33 (mean annual), 5, 10, and 25 years for Bayou San Patricio, Bayou San Miguel, and most other small streams in Sabine Parish. For example: a peak discharge of 5,600 cfs may be expected to occur on the average of once in 10 years or a discharge of 7,200 cfs may be expected to occur on the average of once in 25 years on practically any stream in the

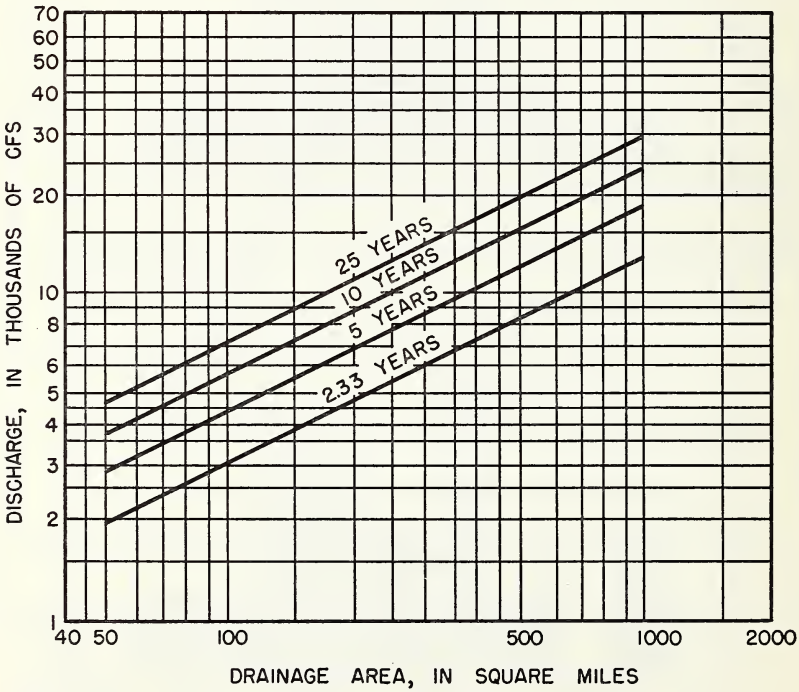


Figure 17. Relation of peak discharge to drainage area—Bayou San Patricio, Bayou San Miguel, and most other small streams within Sabine Parish, La.

parish where the drainage area is 100 square miles (fig. 17.)

Although the curves for northwestern Louisiana were based on data collected within the Red River basin, it is believed that streams in Sabine Parish tributary to Sabine River like Bayous San Patricio and San Miguel would show somewhat the same characteristics as other small streams as the drainage patterns and topography of the areas are similar. Hydrologic comparisons show the streams tributary to Sabine River for which the curves were developed. Figure 18 may be used to estimate the probable magnitude of floods with a recurrence interval of 2.33, 5, 10, and 25 years for the main stem of Sabine River.

This does not necessarily mean that floods of these magnitudes will occur with regularity. These are probable

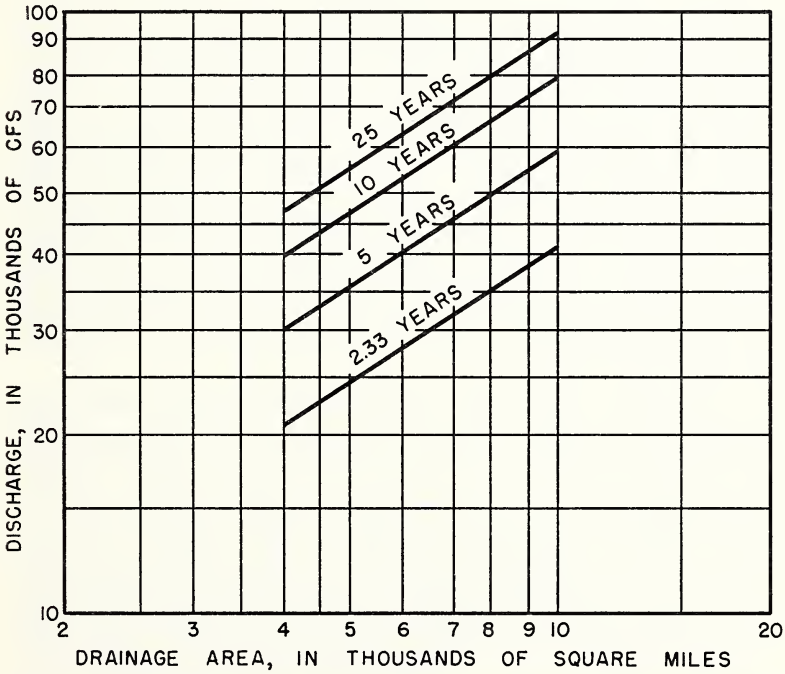


Figure 18. Relation of peak discharge to drainage area, Sabine River.

average intervals between floods of given magnitudes over long periods of time. Two 25-year floods could conceivably occur in consecutive years or even in the same year.

CHEMICAL AND PHYSICAL CHARACTERISTICS

Chemical Quality

Water in its natural state contains dissolved mineral matter and gases in varying amounts and composition. The concentration of mineral matter present in any water is dependent largely upon the various formations of soil and rock over or through which it flows and its length of time in travel. Effluent from oil fields, mines, and industrial wastes often increases the concentration of mineral constituents in a natural stream.

The amount and composition of mineral matter present in surface water changes irregularly as the streamflow changes; therefore, it is desirable to have daily records of chemical analyses at strategic points within each drainage basin. Sampling of this type is lacking in Sabine Parish. However, daily samples of the Sabine River near Ruliff, Texas have been obtained continuously since October 1947 and for the Sabine River near Tatum, Tex. since October 1952. Analyses of samples collected on the Sabine River at Ruliff and at Tatum, Tex. plus samples collected on Bayou San Patricio and Bayou Miguel give an indication of the quality of water in Sabine Parish. The mineral constituents and the physical properties of several streams in the parish are given in table 9.

Tabulated analyses of Sabine River water collected at Tatum and at Ruliff, Tex. for the water years 1954 and 1955 are shown in tables 5, 6, 7, and 8. These analyses indicate the variations in quality of water obtainable from any site along Sabine River between the sampling points. For untreated water, Sabine River water is generally of excellent quality but occasionally there is danger of contamination from East Texas oil fields. Chloride concentrations above 250 ppm are apt to cause a noticeable taste and would not be desirable for domestic supplies and some industrial uses. Examination of tables 5-8 show the chloride concentrations to be well below this limit with the exception of a few times,

when at low water, the chloride concentration of the water of Sabine River near Tatum, Tex. reached 260 ppm. Waters with more than 500 ppm in dissolved solids are not desirable for public uses. Water having a dissolved-solids content of several thousand parts per million is sometimes successfully used for irrigation provided the soluble salts are removed through the application of large volumes of water on well-drained lands. The dissolved-solids content of streams in and near Sabine Parish is generally low, ranging from 35 to 1,390 ppm. However, the silica concentrations ranging from 2 to 24 ppm found in these waters exceed that tolerated by certain industrial uses such as steam generation.

The chemical composition of the water in the Sabine River varies considerably throughout the year. This variation is shown graphically by figure 19 which illustrates specific conductance with respect to time spread over a water year. This figure also shows the relation of total hardness, dissolved solids, and discharge with respect to time for Sabine River near Tatum, Tex. for the water year 1955. Considerable attention is given to hardness of water in its usage for domestic and industrial purposes. Waters with less than 60 ppm hardness are usually rated as soft and suitable for many purposes without further softening. Analyses of waters taken from Bayou San Miguel near Zwolle and Bayou San Patricio near Noble indicate, in general, the hardness to be much less than 60 ppm. Hardness of water from Sabine River near Tatum, Tex. (table 5), is more than 60 ppm at times. Water having less than 100 ppm, for all practical domestic uses and most industrial purposes, is not particularly objectionable. As shown in table 5, the specific conductance varies with the type of minerals present and the degree of ionization of these minerals as well as with the temperature of the water. Figure 20 shows the relation of chloride concentration of water from the Sabine River near Tatum, Tex. to specific conductances (in micromhos at 25°C) for the same period. The relationship is almost linear.

Analyses of periodic samples collected from streams in the parish are given in table 9. The dissolved-solids con-

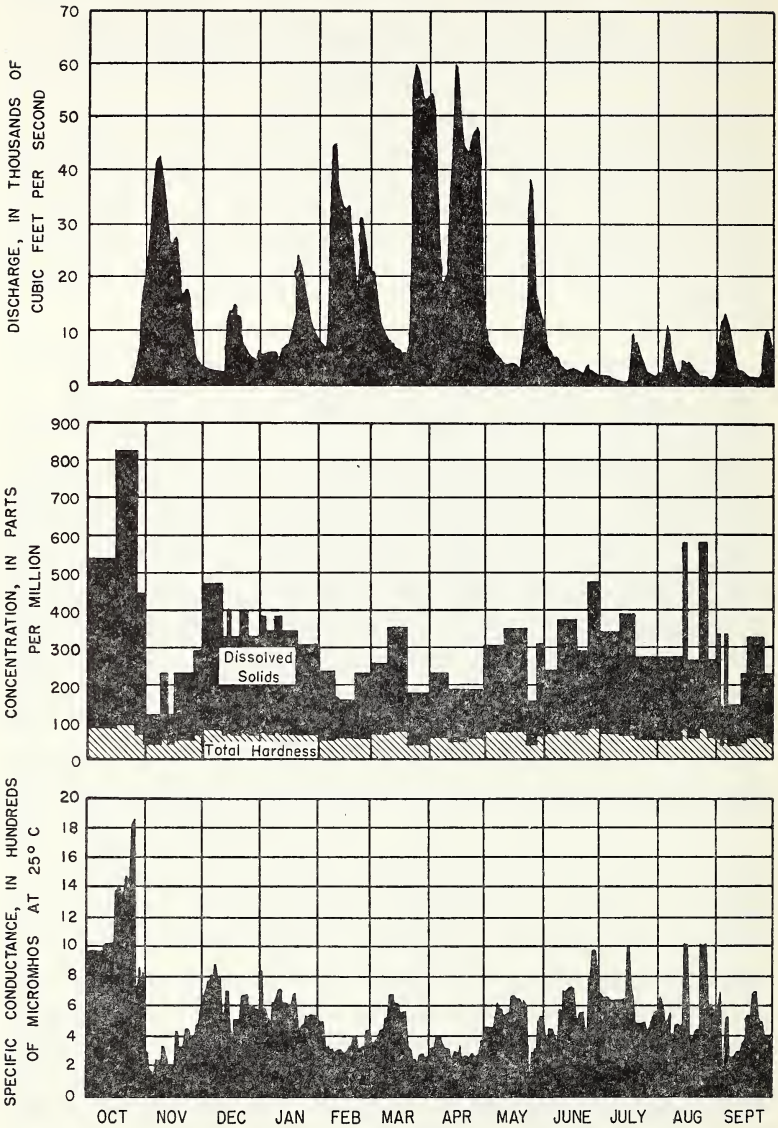


Figure 19. Relation of hardness, dissolved solids, and specific conductance to streamflow, Sabine River near Tatum, Tex., water year October 1954 to September 1955.

tent of water from Bayou San Miguel is generally low and ranges from 32 to 104 ppm. In contrast the dissolved-solids content of the water from Bayou San Patricio, except for one sample, ranged from 49 to 304 ppm, and the chloride concentrations were higher than for Bayou San Miguel. The higher chlorides may indicate escape of oil-field wastes into this bayou. The presence or absence of such contamination in other bayous in the parish could be determined by appropriate sampling programs. In general, if these analyses for Bayou San Miguel are representative of the other small streams in the parish, any of the small streams would be suitable for a surface supply for a small city or other type of use.

Temperature

Surface-water temperatures vary with the surrounding ing air temperatures, except in those cases where the streams are spring fed or some other unusual circumstances

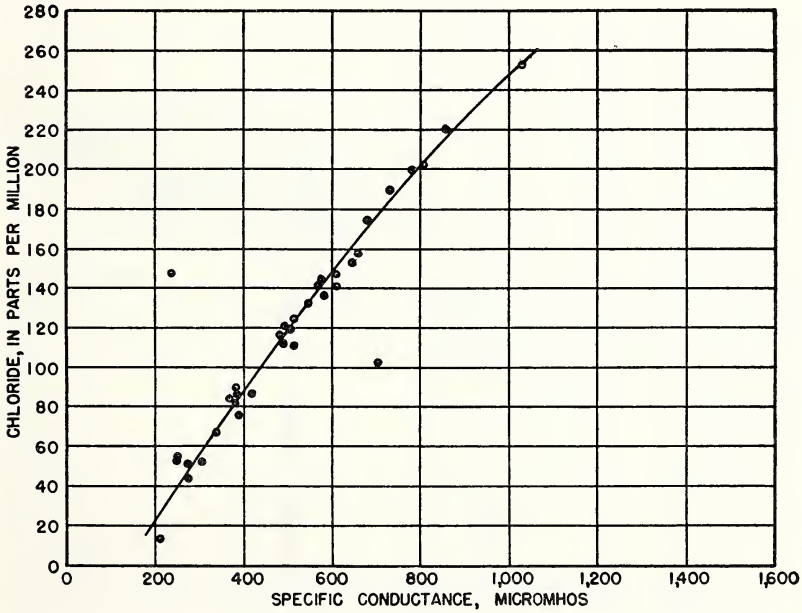


Figure 20. Relation of chloride concentration to specific conductance, Sabine River near Tatum, Tex., water year October 1954 to September 1955.

affect the temperature. In general, surface-water temperatures are nearly the same as the average air temperatures in the winter months, whereas, during those months of low flow, the average surface-water temperature is slightly higher than the monthly air temperature. Figure 21 shows the maximum, average, and minimum monthly water temperature of Sabine River near Tatum, Tex. for the water year ending September 30, 1955. Average monthly air temperatures for the same period at Longville, Tex. also appear on this graph for comparative analysis. Longville is approximately 18 miles upstream from Tatum, and is the nearest climatological station having a complete record of daily air temperatures.

Observations of water temperature have been made on Bayou San Patricio near Noble, La. since December 1951, of Bayou San Miguel near Zwolle, La. since December 1954, of Bayou Toro near Toro, La. since November 1955, and of Bayou La Nana near Zwolle, La. since October 1955. Tabulated below are the results of those observations:

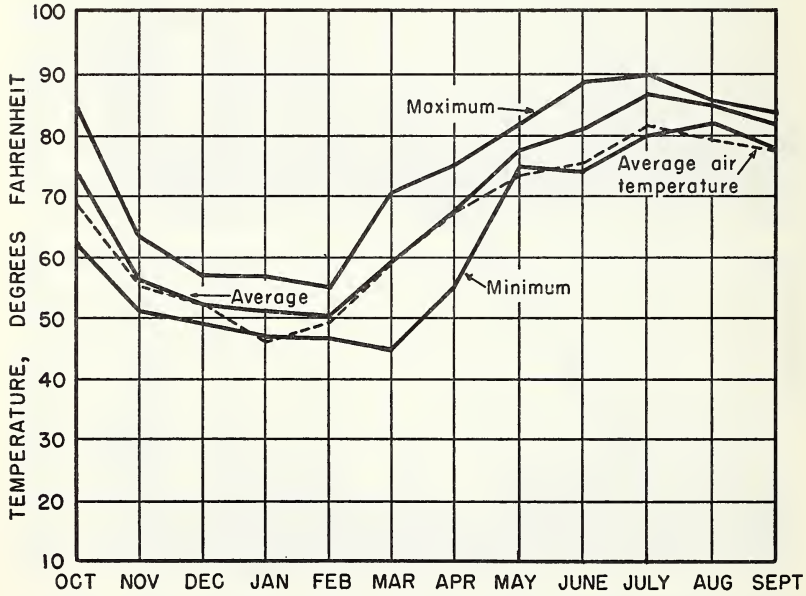


Figure 21. Monthly variation of maximum, average, and minimum water temperature of Sabine River near Tatum, Tex., water year October 1954 to September 1955. Average monthly air temperature at Longville, Tex. for the same period.

BAYOU SAN PATRICIO NEAR NOBLE, LA.

Date	Water Temp. (°F)	Date	Water Temp. (°F)
Dec. 13, 1951	49	Jan. 5, 1956	46
Feb. 14, 1952	61	Jan. 31	55
Apr. 10	62	Feb. 29	60
May 15	72	Mar. 27	65
June 19	89	Apr. 25	66
Aug. 20	79	May 23	62
Oct. 30	48	June 20	78
Dec. 18	49	July 18	84
June 29, 1953	47	Jan. 5, 1957	53
July 6	80	Feb. 3	48
Oct. 18	66	Mar. 1	56
Dec. 18	42	Apr. 19	64
Jan. 13, 1954	42	May 15	72
Feb. 16	64	June 14	72
Mar. 16	52	July 8	81
Apr. 21	67	Aug. 5	78
May 20	69	Sept. 3	81
June 23	83	Nov. 4	72
Nov. 16	67	Nov. 8	62
Dec. 17	49	Dec. 9	38
Jan. 12, 1955	51	Jan. 16, 1958	44
Feb. 9	49	Feb. 6	68
Mar. 9	54	Mar. 14	50
Apr. 1	59	Apr. 7	52
Apr. 29	75	June 5	82
May 24	71	July 14	81
June 21	75	Aug. 15	85
June 30	74	Sept. 8	74
July 27	85	Sept. 21	74
Aug. 14	76	Oct. 10	66
Sept. 14	74	Nov. 4	49
Oct. 18	63	Dec. 17	52
Nov. 30	40		

BAYOU LA NANA NEAR ZWOLLE, LA.

Date	Water Temp. (°F)	Date	Water Temp. (°F)
Oct. 18, 1955	64	June 14	76
Nov. 29	47	Aug. 8	82
Jan. 4, 1956	49	Sept. 5	83
Jan. 31	55	Oct. 10	60
Feb. 24	68	Dec. 12	43
Mar. 28	61	Jan. 17, 1958	45
Apr. 25	64	Feb. 11	40
May 22	70	Mar. 15	50
June 20	78	Apr. 11	61
July 18	83	May 11	70
Aug. 15	81	June 5	79
Nov. 6	67	July 15	84
Dec. 4	49	July 24	86
Jan. 5, 1957	51	July 25	85
Jan. 31	54	Aug. 21	76
Mar. 1	58	Sept. 11	72
Apr. 8	61	Sept. 22	75
Apr. 29	61	Oct. 16	66
May 1	65	Dec. 8	56

BAYOU TORO NEAR TORO, LA.

Date	Water Temp. (°F)	Date	Water Temp. (°F)
Nov. 29, 1955	47	Aug. 13	81
Jan. 4, 1956	52	Sept. 16	72
Jan. 31	----	Oct. 17	81
Feb. 28	61	Nov. 18	67
Mar. 27	63	Dec. 18	62
Apr. 24	64	Jan. 15, 1958	46
May 22	68	Feb. 18	48
June 19	80	Mar. 19	46
July 17	87	Apr. 10	58
Aug. 14	80	May 12	74
Sept. 18	77	June 12	75
Oct. 9	70	July 7	78
Nov. 6	68	Aug. 14	85
Dec. 4	51	Aug. 21	80
Jan. 4, 1957	56	Aug. 27	85
Jan. 30	57	Sept. 3	80
Feb. 28	56	Oct. 9	63
Apr. 3	67	Nov. 20	64
May 6	64	Dec. 10	47

BAYOU SAN MIGUEL NEAR ZWOLLE, LA.

Date	Water Temp. (°F)	Date	Water Temp. (°F)
Dec. 17, 1954	45	June 14	72
Feb. 9, 1955	65	Nov. 4	76
Apr. 4	65	Dec. 9	36
Apr. 29	79	Jan. 17, 1958	44
May 24	69	Feb. 6	68
June 21	75	Mar. 15	57
July 27	80	Apr. 11	54
Sept. 14	75	June 5	81
Feb. 29, 1956	68	July 14	72
Mar. 27	63	July 24	86
Apr. 25	62	Sept. 11	76
May 23	72	Sept. 12	72
June 20	84	Sept. 17	81
July 18	84	Sept. 21	75
Dec. 4	51	Sept. 22	74
Jan. 31, 1957	57	Nov. 4	50
Mar. 1	55	Dec. 17	56
Apr. 8	65		

USES OF SURFACE WATER

Little use is made of surface water for domestic or industrial supplies in Sabine Parish. The towns of Many, Pleasant Hill, and Zwolle all obtain public water supplies from underground sources.

In dry seasons more and more use is being made of surface waters in the parish for irrigation purposes. Even though the parish is situated in the humid zone where the

normal precipitation is usually adequate during the growing season for most agricultural pursuits, comparatively short periods of drought that adversely affect crops are not uncommon. Several private sprinkler-type irrigation systems that draw water from bayous have been installed in the past few years, especially along Bayou Toro and Bayou Negreet.

The towns of Pleasant Hill and Zwolle rely on local surface-water sources for disposal of most of their sewage, some of which enters the streams directly as raw sewage and some in the form of effluent from private septic tanks. Sewage from the town of Many receives treatment in Imhoff tanks and settling beds. The effluent is discharged into Blackwell Creek.

Streams in Sabine Parish do not play an important part in navigation at the present time, owing to their inability to carry large modern craft. Sabine River played an important part in earlier times when it was used by small craft.

FUTURE NEEDS

The populaiton of Sabine Parish has been comparatively static or slightly declining, a shift from rural farm to rural non-farm causing increases in the population of the larger towns of Many, Pleasant Hill, and Zwolle. The demand on the water system for the town of Many has exceeded the capacity of its supply system on numerous occasions in the past. The development of new well fields or a supplementary surface-water supply is necessary to meet the growing demand for water in Many. Fortunately, the reservoir that will be formed on Sabine River, when the proposed Toledo Bend dam is built near the southern tip of the parish, will bring an adequate surface-water supply within easy reach of the town of Many.

STRATIGRAPHIC SECTION IN SABINE PARISH

System	Series	Group	Formation	Thickness (feet)	Character and Water Supply
Quaternary	Pleistocene and Recent		Valley alluvium and Terrace deposits	0–60	Clay, silt, sand, and fine gravel. Sand yields adequate supplies of hard water to domestic and stock wells.
				0–100	Clay, silt, sand, and gravel. Deposits not continuous; not important for water supply. Soft water for domestic and stock supplies may be obtained in some places.
Tertiary	Miocene		Catahoula	650	Calcareous clay. Siltstone and sandstone. Some beds of medium-to coarse-grained sand termed "rice-grained" sand. Sands yield domestic supplies of iron-bearing water.
	Oligocene	Vicksburg	Undifferentiated	600–700	Silt, clay, and marl, with a few thin beds of fine-grained sand. Not an aquifer.
	Eocene	Jackson			
		Claiborne	Cockfield	800–900	Thin to massive-bedded fine-grained sand, sandy clay, and lignitic silty clay. Sands yield soft water for domestic, stock, and small industrial supplies.
			Cook Mountain	240–330	Mostly clay with some thin beds of sand. Not important as an aquifer. Small supplies for domestic and stock use in places.
			Sparta Sand	200–440	Lower part mostly fine-to medium-grained sand. Upper part more clayey. Sands yield adequate supplies of soft water to small industrial and municipal wells. May be capable of furnishing large supplies.
			Cane River	180–280	Glauconitic sandy clay and marl. Not an aquifer.
			Carrizo Sand	?–130	Fine-to medium-grained sand. Possibly important aquifer, but difficult to distinguish from Wilcox Group in most places.
	——?——	Wilcox	Undifferentiated	2,400–3,500	Interbedded sand, silt, and clay. Lignitic, glauconitic, and calcareous. Sands are very fine to medium grained. Sands yield adequate supplies of soft to moderately hard water to domestic, stock, and municipal wells. Iron in high concentrations is common. Most important aquifer in Sabine Parish because of its large area of outcrop.
	Paleocene	Midway	Porters Creek Clay	650-1,100	Lignitic and limy clay. Not an aquifer.
			Kincaid		
Cretaceous Rocks					

GEOLOGY

By Roy Newcome, Jr., and George D. Graeff, Jr.

GENERAL STRATIGRAPHY

The sediments exposed in Sabine Parish consist of sands and clays of Tertiary and Quaternary age. Included in the Tertiary system are the Midway Group of Paleocene age, the Wilcox Group of Paleocene and Eocene ages, the Claiborne and the Jackson Groups of Eocene age, the Vicksburg Group of Oligocene age, and the Catahoula Formation of Miocene age. Because of the southward dip of the strata, younger formations crop out successively to the south. Sediments of Quaternary age consist of alluvium in stream valleys and relatively thin deposits which form discontinuous terraces flanking the valleys.

Louisiana and neighboring states have been a depositional area for millions of years. The alternate seaward building of deltas by the Mississippi and other rivers and landward subsidence has caused the cyclic deposition of continental and shallow marine strata consisting of sand, lignitic shale, and calcareous silt and clay. The deposition of Quaternary material, which subsequently was sculptured into terraces, and alluviation of the modern river valleys complete the geologic picture in Louisiana. The materials underlying the terraces were divided by Fisk (1938) into four formations which he named, in order of deposition, the Williana, Bentley, Montgomery, and Prairie. According to Fisk, sea level rose during the interglacial stages as a result of the melting of the glacial ice, and alluvium was deposited in the valleys. Sea level fell during the glacial stages, and revitalized streams cut down through the material just deposited. Successive downcuttings started lower each time, preserving the older terraces.

The stratigraphy of Sabine Parish has been described in detail by Andersen (1960). For the purposes of this study it was deemed unnecessary to consider each formation separately unless it represents a hydrologic entity. Thus, the Jackson and Vicksburg Groups, which are composed predominantly of clay and have little positive hydrologic significance, are not subdivided into formations

in the stratigraphic column of this report. The Wilcox Group is undivided because its various formations are not readily distinguished in the subsurface. The geologic map (fig. 22) and the cross sections (pls. 2-4) show the general distribution and relative positions of the Tertiary rocks as indicated by subsurface studies and the cited references.

Tertiary Rocks

MIDWAY GROUP OF PALEOCENE AGE

The Midway Group is represented in the subsurface in Sabine Parish by the Kincaid Formation and the Porters Creek Clay which consist respectively of dark-gray silt and dark-gray lignitic and limy clay. They have an aggregate thickness ranging from 650 to 1,100 feet and averaging 800 feet. The Kincaid occupies only the lower 10 to 20 feet of this thickness. The formations do not crop out in Sabine Parish; the top of the Porters Creek, as indicated on electrical logs, ranges in depth from about 300 feet below sea level at the northern edge of the parish to more than 7,000 feet at the southern boundary (fig. 23). The Kincaid-Porters Creek interval is an important stratigraphic marker because of its distinctive trace on electrical logs. (See pls. 2 and 4.)

WILCOX GROUP OF PALEOCENE AND EOCENE AGE

The Wilcox Group consists of alternating sand, silt, and clay beds. Samples show the sands to be gray or "pepper and salt" and to have a medium- to fine-grained texture; the clays are dark gray and sticky when wet. The thickness of the Wilcox ranges from about 500 feet in the northern part of the parish (T. 10 N.), where erosion has removed much of the section, to 3,500 feet in the southeast corner (T. 5 N., R. 9 W.). The Wilcox is about 2,400 feet thick at the southern boundary of the outcrop area. As the bottom of the Wilcox Group marks the top of the Porters Creek Clay, the contour map on top of the Porters Creek (fig. 23) indicates the maximum extent below sea level of the Wilcox throughout the parish. The altitude of the top of the Wilcox Group is shown by the contour map in figure 24.

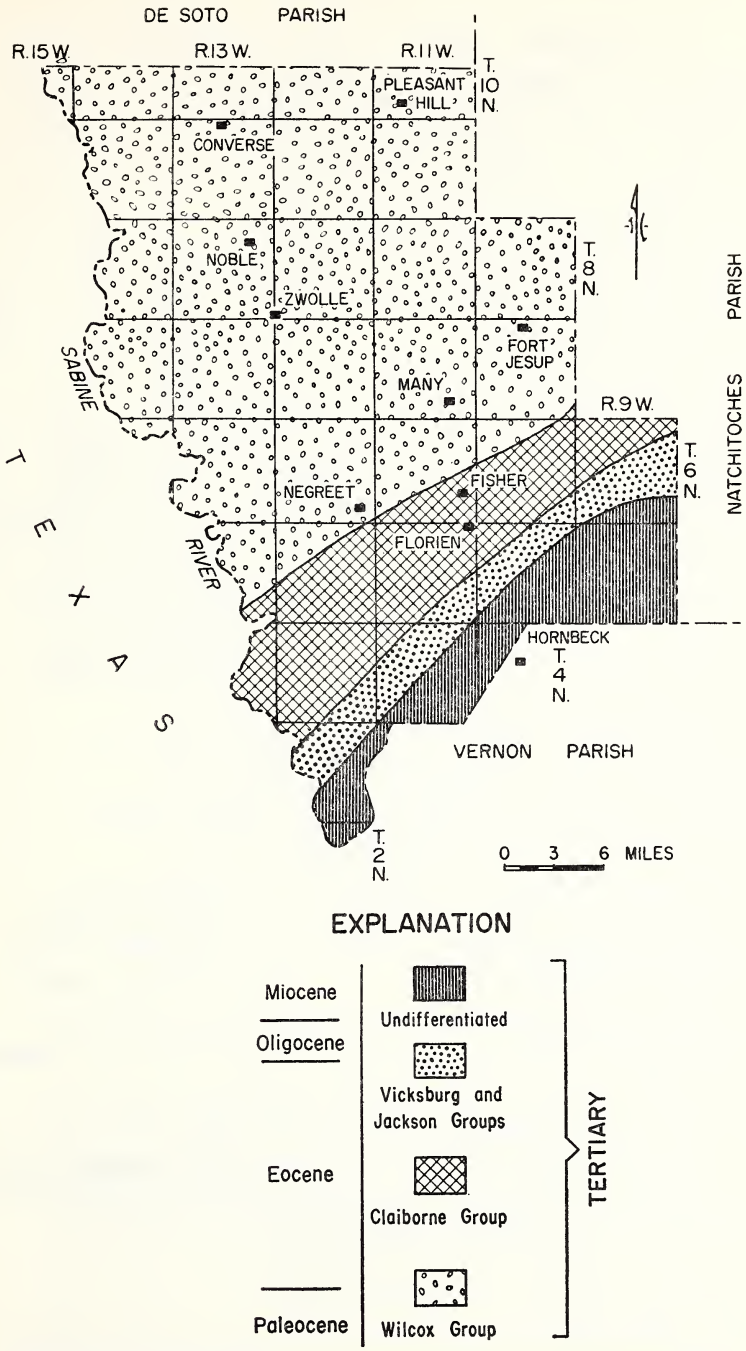


Figure 22. General Tertiary geologic map of Sabine Parish, La.

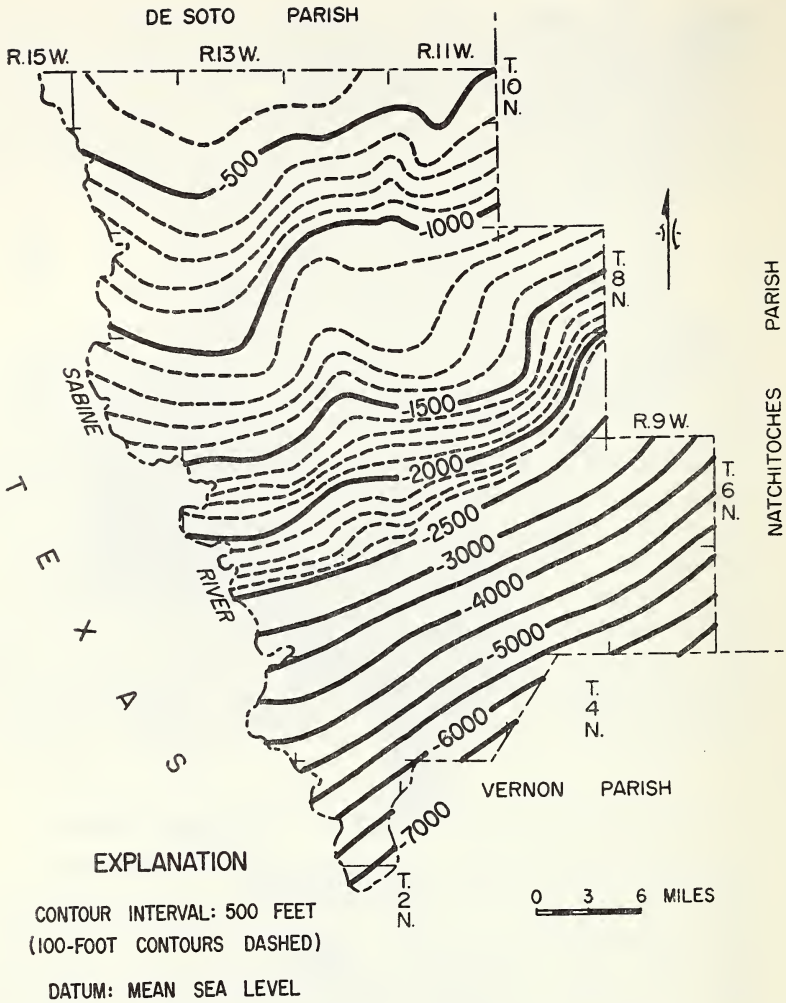


Figure 23. Contours on top of the Porters Creek Clay in Sabine Parish, La.

CLAIBORNE GROUP OF EOCENE AGE

The Claiborne Group consists of the Carrizo Sand, Cane River Formation, Sparta Sand, Cook Mountain Formation, and Cockfield Formation.

*Carrizo Sand**

*Editor's Note

Surface geological mapping in Caddo Parish by Lou-

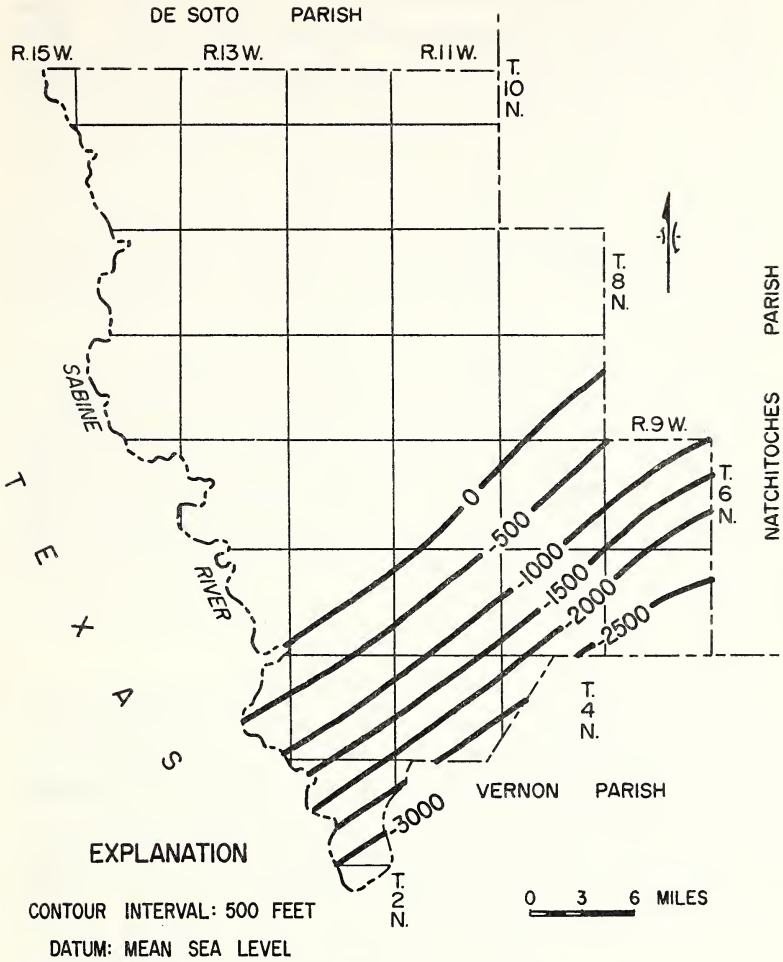


Figure 24. Contours on top of the Wilcox Group in Sabine Parish, La.

isiana Geological Survey personnel has found the upper Carrizo to intertongue with the lower Reklaw, the oldest marine formation in the Claiborne Group in that area (Smith, map manuscript 1962). Earlier Louisiana Geological Survey bulletins have retained Carrizo in the upper Wilcox. However, evidence suggesting a local unconformity at the base of the Carrizo in parts of Sabine Parish has recently been advanced (Durham and White 1960).

The Carrizo Sand, a well-known formation in Texas, is poorly exposed in Sabine Parish. Along with the overlying Cane River Formation the Carrizo has been faulted

out in much of its normal outcrop area in this parish. Elsewhere in northern Louisiana outcrops of the unit are similar in appearance to the younger Sparta Sand—both are characterized by massive cross-bedded sands. In the subsurface the Carrizo is discernible on electrical logs as a massive sand bed of variable thickness underlying the clay of the Cane River Formation. The maximum observed thickness is about 130 feet; however, the thickness obtained from electrical logs is questionable because in places the Carrizo overlies sands of the uppermost beds of the Wilcox.

Geologists in Louisiana commonly include the Carrizo Sand in the Wilcox Group, because of the difficulty in recognizing the Wilcox-Carrizo contact in the subsurface; whereas, the upper contact wth the Cane River Formation is easily recognized. The U.S. Geological Survey considers the Carrizo Sand to be the basal formation of the Claiborne Group. Its physical and hydrologic properties justify this assignment.

Cane River Formation

The Cane River Formation at its type locality on the banks of Cane River Lake at Natchitoches, Louisiana, is composed of marine clay and marl. On electrical logs the formation is easily identified by the clay interval between the sandy beds of the Sparta and Carrizo. A distinctive feature of the Cane River on electrical logs is the deflection caused by a marl bed that commonly is about 50 feet above the bottom of the formation.

No outcrops of the Cane River had been identified in Sabine Parish prior to detailed mapping by Andersen (1960). The reasons commonly suggested for this nonappearance were faulting-out of the formation or nondeposition of the sediments. Subsequent subsurface evidence showed typical Cane River deposits in southern Sabine Parish where the formation ranges in thickness from 180 to 280 feet. However, a southwest-trending area near Negreet, where the Cane River should be on the surface, generally is occupied by sandy material that does not correlate at the surface or on electrical logs with the Cane River Formation. Instead, the material comprises out-

crops of the Wilcox Group, Carrizo Sand, and Sparta Sand. A very few small exposures of Cane River type material were reported by Andersen (1960). The probable cause of the sparsity of Cane River outcrops in this area is described in the section, "Structure."

Sparta Sand

The Sparta Sand is a distinctive formation throughout most of northern Louisiana. In Sabine Parish the Sparta Sand crops out in a narrow northeast-trending band just south of Negreet, and is in the subsurface southeast of the outcrop area. Electrical logs show the Sparta to be composed of massive to thin-bedded sands interbedded with thin clays. The proportion of sand to clay is much higher and the sands are generally coarser than in any other of the pre-Quaternary formations, except the Carrizo Sand. The uneroded thickness of the formation ranges from about 200 feet near the outcrop to 440 feet near the southeastern margin of the parish. Its position in the subsurface is illustrated by the contour map in figure 25.

Cook Mountain Formation

The Cook Mountain Formation overlies the Sparta Sand. Its outcrop is parallel to and southeast of the Sparta outcrop and passes through the Fisher area. The formation consists chiefly of clay, but contains a few thin and irregular sand beds. On many electrical logs its trace resembles that of the Cane River formation except for the distinctive marl bed "kick" in the Cane River. The Cook Mountain is 240 to 330 feet thick in Sabine Parish.

Cockfield Formation

Sands and clays of the Cockfield Formation overlie and crop out to the southeast of the Cook Mountain Formation. The Cockfield is 800 to 900 feet thick and consists largely of alternating thin sand and clay beds, although in places sand beds 50 feet or more in thickness have been reported. Drillers' logs indicate that material from the Cockfield is mostly gray clay and fine-grained sand. The contour map in figure 26 shows the subsurface position of the formation.

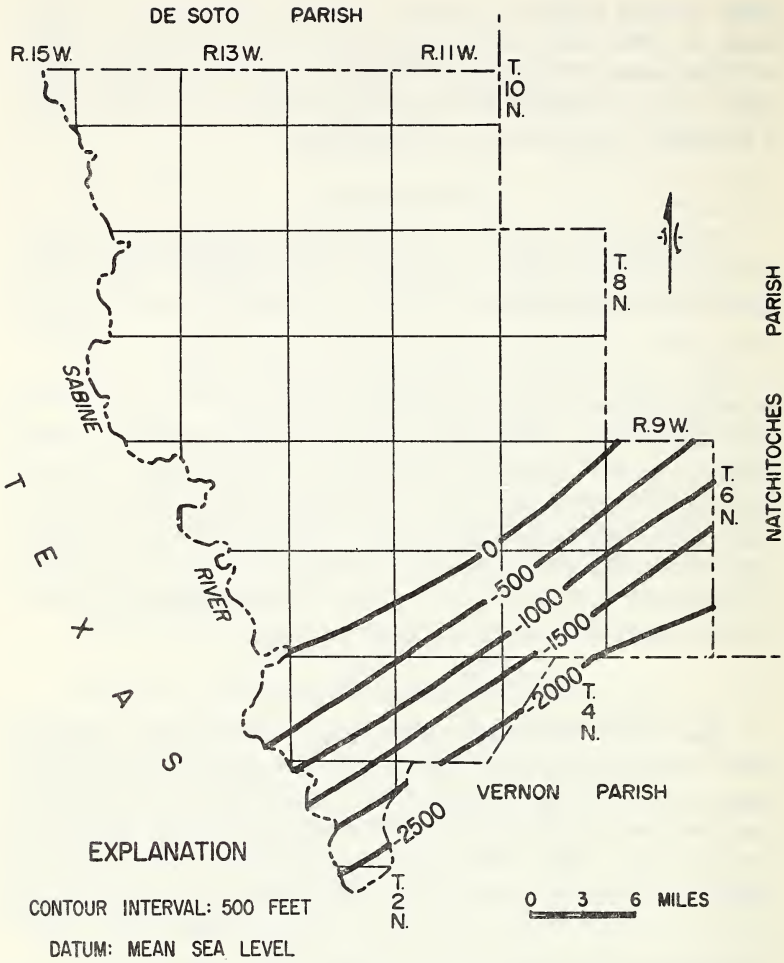


Figure 25. Contours on top of the Sparta Sand in Sabine Parish, La.

JACKSON GROUP OF EOCENE AGE AND VICKSBURG GROUP OF OLIGOCENE AGE

The Jackson and Vicksburg Groups crop out southeast of the Claiborne Group and form a lowland in southeastern Sabine Parish. The two groups consist chiefly of 600 to 700 feet of clay containing thin marl beds in the lower part. Formation samples obtained from a shallow boring in the outcrop consist of tan and greenish-gray clay. The two groups are not easily differentiated on electrical logs, although the base of a sandy interval 500 to

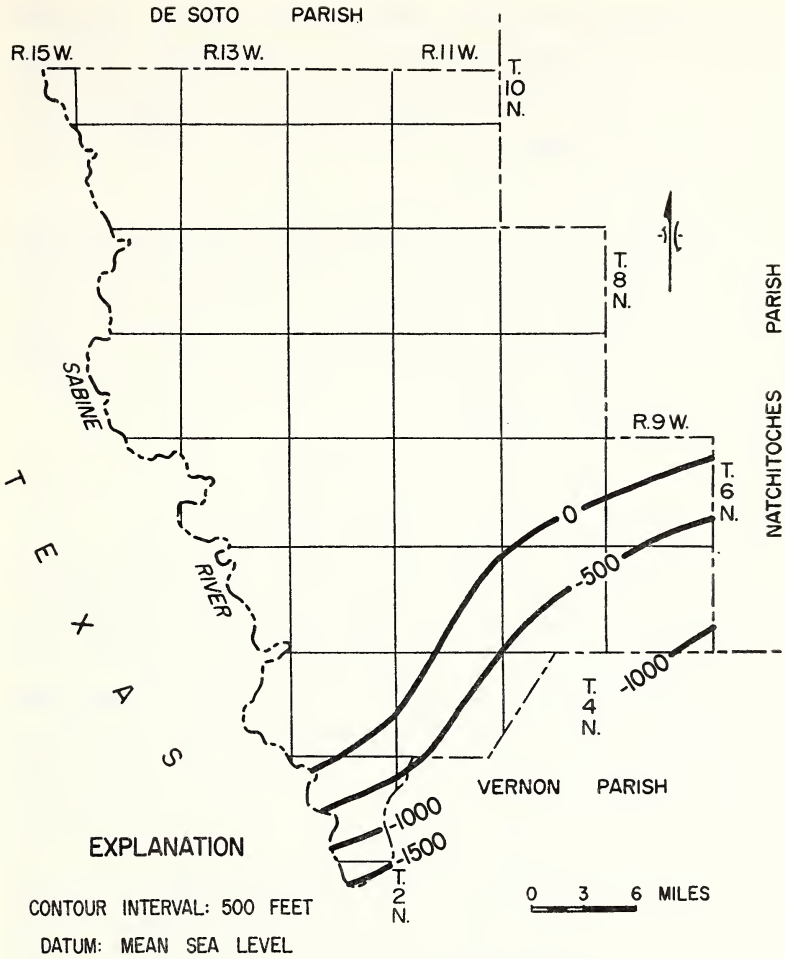


Figure 26. Contours on top of the Cockfield Formation in Sabine Parish, La.

700 feet above the bottom of the Jackson may mark the contact.

ROCKS OF MIOCENE AGE

Catahoula Formation. Rocks of Miocene age are represented by the Catahoula Formation (Miocene?) whose resistant sandstones form an upland in the outcrop area near the southeastern margin of Sabine Parish. The upland, known as the Kisatchie Wold, extends eastward into

Natchitoches Parish and westward into Texas. The lower part of the formation consists of alternating sandstones and coarse-to medium-grained sands with subordinate beds of clay. Electrical logs indicate that the formation extends as much as 360 feet below the land surface in the southern part of the outcrop area.

The upper part of the Catahoula Formation contains a high percentage of glauconitic clay. The name Fleming Formation (Fisk 1940) has been given to the sand and green clay beds which are present in a very narrow strip along the southeastern boundary of Sabine Parish. Rocks of Miocene age are shown on the map in figure 22 as Miocene undifferentiated.

Quaternary Rocks

PLEISTOCENE AND RECENT DEPOSITS

Sediments of Quaternary age have been deposited in stream valleys cut into the Tertiary bedrock formations. The Sabine River valley was formed in Pleistocene time and was subjected to drowning and rejuvenation corresponding to periods of encroachment and retreat of the seas accompanying glacial fluctuations of that epoch. As succeeding valleys were cut deeper, remnants of the flood plains of older valleys remained as terraces flanking the younger valleys. Only two terraces can be distinguished along the Sabine River valley in Sabine Parish; these form a very narrow, discontinuous strip along the river south of Pendleton Bridge. The deposits under the terrace surfaces consist generally of fine-to coarse-grained sand intermixed with some gravel. They range greatly in thickness, the maximum being about 100 feet.

The flood plains of the present stream valleys are underlain by Quaternary alluvium that rests on the Tertiary formations. More than 50 feet of alluvial clay and sand were penetrated by borings in the valley of the Sabine River. The thickness of these deposits decreases toward the eastern valley wall which is 1 to 5 miles from the river.

STRUCTURE

During Tertiary and Quaternary time sediments were

deposited in the Sabine Parish area as flat-lying or very slightly inclined beds. The weight of material at the continental margin caused a seesawlike adjustment to the north that raised and tilted the beds into approximately their present position. The major Tertiary uplift of this area probably was associated with Miocene deposition in south-central Louisiana. A more localized structure, but one of primary importance in the area of this study, is the Sabine uplift, a pear-shaped dome in northwestern Louisiana and eastern Texas. Minor folds on the dome have accumulated oil and gas and are sites of several successful oil and gas fields.

Sabine Parish is on the southern flank of the Sabine uplift, and within the parish the strata dip south to southeast. The dip of the Paleocene sediments increases southward from 30 to 330 feet per mile, but dips of younger formations are somewhat less because of a gradual thickening of the geologic section. The cross sections in plates 2-4 show some of the structural features of Sabine Parish. In addition, the contour map on the top of the Porters Creek Clay (fig. 23) reflects the overall parish structure. The Porters Creek-Wilcox contact was used for this map because it is the youngest contact that is not exposed and eroded, and therefore occurs throughout the parish in the subsurface.

Northeast- and northwest-trending faults are numerous and closely spaced within the parish. The abundance of faults identifiable on the surface in Sabine Parish is illustrated by Andersen (1960, fig. 21). The faults shown on plate 4 represent a few of the larger faults or fault zones that can be observed on aerial photographs. They are shown on Andersen's geologic map (1960, pl. 1). These faults are related possibly to an older fracture system and have been active recently (Wermund, 1955). A possible reflection of faulting is the large number of southwest-trending straight segments of the Sabine River's course and the acute angularity of the bends. This is particularly noticeable in the stretch of river west of Negreet (Tps. 5 and 6 N.).

An important effect of faulting in the parish is the al-

most complete removal of the Cane River Formation from the surface. This is attributed to one or more strike faults which have placed the Sparta Sand against the Carrizo Sand and upper beds of the Wilcox in the Negreet-Fisher area.

Much of the faulting in Sabine Parish probably is associated with structural movements that have made southern Sabine Parish a structural highland relative to southern Natchitoches Parish on the east. Although the general strike of the beds in these adjacent areas is the same, a twisting action which evidently occurred along the Sabine-Natchitoches parish boundary has placed the Midway-Wilcox contact in most of southern Sabine Parish more than 1,000 feet higher than it is in Natchitoches Parish. This anomaly dies out at the southern extremities of the two parishes.

GROUND WATER

By Roy Newcome, Jr., and George D. Graeff, Jr.

WELL-NUMBERING SYSTEM

In this report wells are numbered in the order that they were recorded. For example, well Sa-1, in which the prefix "Sa" is the abbreviation for "Sabine," was the first well recorded by the U.S. Geological Survey in Sabine Parish. For each well the data are on file, and the location is plotted and numbered on the parish well-location map. Not all of the wells recorded in Sabine Parish are included in the table of well records (table 10) or shown on the well-location map (pl. 5) in this report.

Wells in this report are located by section, township, and range. Each township, as shown on plate 5, contains 36 one-mile-square sections in which wells are located as indicated in the well-record table (table 10). Regular sections are numbered as in the example shown on plate 5.

SOURCE AND OCCURRENCE

The source of ground water in Sabine Parish is precipitation in the parish or in neighboring parishes. Part of the rain on the earth's surface runs off directly into streams or lakes, and part of it returns to the atmosphere by evaporation and transpiration. The remainder of the water, which probably constitutes less than 5 percent of the total precipitation, infiltrates the ground and occupies interstices in the soil and rocks. Water from the aquifers is later given up by means of springs and seeps, outflow to streams and other aquifers, and discharge from wells.

Ground water in Sabine Parish occurs in sand of the Tertiary formations, in sand and gravel of terraced Pleistocene remnants, and in sand of the alluvial valleys. Water in the Tertiary sands is confined generally by overlying and underlying clay beds. It is thus under hydrostatic pressure and rises in wells that penetrate the sand. This mode of occurrence is termed "artesian conditions," and water levels in wells define a piezometric, or presure, surface whose height is dependent in part upon the altitude of the area of recharge, which is in most places the outcrop

of the sands. Water in the alluvial sands, the terrace deposits, and the outcrop areas of the Tertiary sands generally occurs under "water-table conditions" and does not rise in wells. Water-table conditions exist where permeable rocks receive recharge from the surface through overlying permeable material and thus the water table is under atmospheric pressure only. Water levels in wells and hydraulically connected streams and other water bodies define the surface of the water table, which is a subdued replica of the topography.

RECHARGE AND MOVEMENT

Except in their outcrop areas, the Tertiary sands are covered by relatively impermeable material, and recharge is believed to occur chiefly by downward movement of rainfall at the outcrop. The alluvial sands and the terrace deposits are recharged by seepage through overlying sand, silt, and clay, and by the lateral movement of water from adjacent Tertiary formations. The movement of water in artesian aquifers occurs as a result of differences in head—that is, from areas of high head to areas of lower head. Points of discharge are points of pressure relief which induce the movement of water in their direction. In water-table aquifers water moves in response to gravity to points of discharge. These principles apply whether the discharge takes place into deeply cut river valleys or into individual wells. Where ground-water movement is toward river valleys a general downward slope of the water table or piezometric surface toward the valleys exists. Around a well or group of wells the lowering of the water table or piezometric surface takes the form of an inverted cone, termed the "cone of depression," whose apex is the water level at the center of pumping and whose radius increases in every direction until it reaches either a source of recharge or a barrier to the flow of ground water. The movement of ground water in response to the described influences is illustrated on figure 27.

DISCHARGE

Ground water in Sabine Parish is discharged by seepage into streams and lakes, withdrawal from wells, and

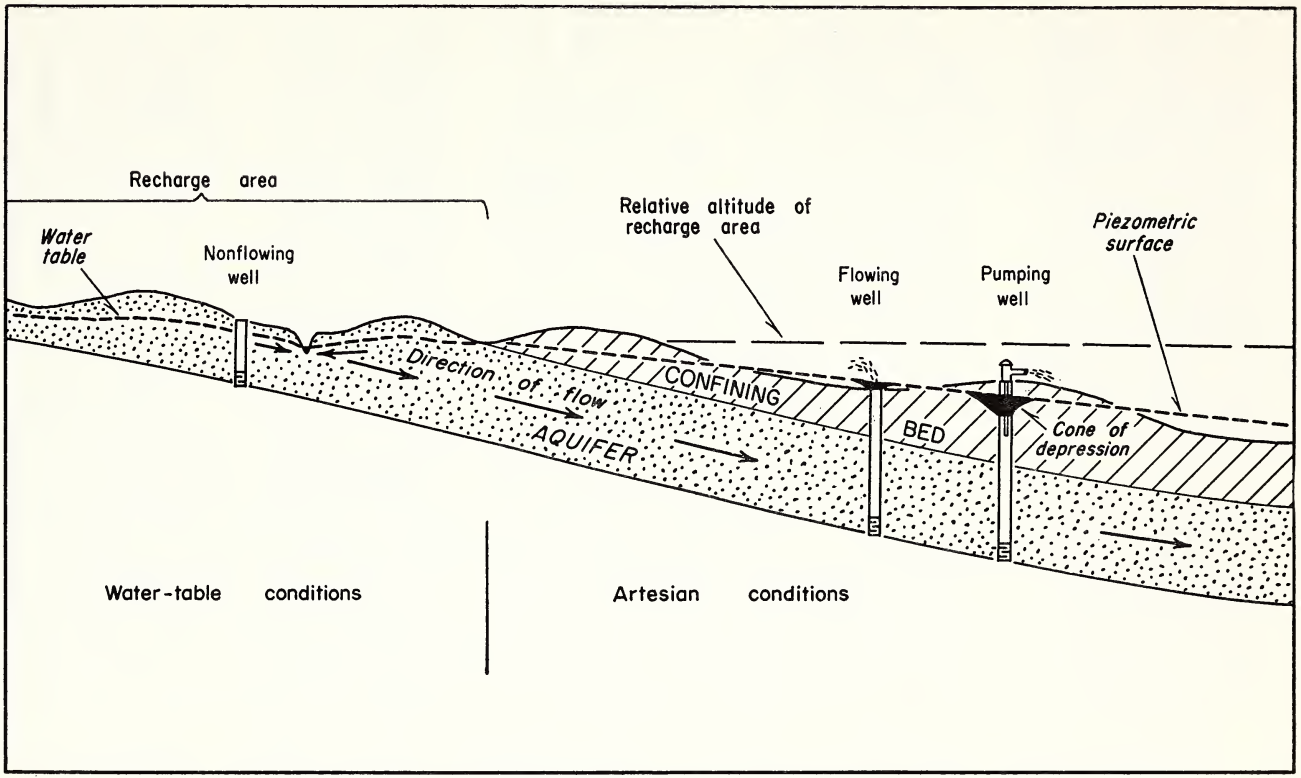


Figure 27. Schematic diagram illustrating the occurrence and movement of ground water.

by evaporation and transpiration in areas where the water table is at or very near the land surface.

Several seeps and springs exist along an east-west trending line south of Negreet, possibly marking the line of a fault. Some of these springs are used for domestic and stock supplies. Ground water is discharged by seeps into the Sabine River and its tributary streams during low-river stages. Probably the entire low flow of the smaller streams in the parish is maintained by ground-water seepage.

The public water supplies of Many, Zwolle, Pleasant Hill, Converse, and Fisher are obtained from wells. Wells supply sawmills, ice plants, and a bottling plant in the parish. Practically all of the rural domestic and stock supplies are obtained from wells, and although the individual pumpage is small, the aggregate pumpage is about 0.5 mgd (million gallons per day). Total withdrawals of ground water in Sabine Parish average about 1 mgd.

TYPES OF WELLS AND METHODS OF LIFT

Dug and driven wells averaging 25 feet in depth are common in the flood-plain areas and in the outcrop areas of the Tertiary sands. The rope and bucket method of lift is used in many of the dug wells, but electrically operated pumps and pitcher pumps are common in both dug and driven wells.

Domestic and stock wells in the flood plain and highland areas generally are drilled by the hydraulic-rotary method and are constructed with 2-to 4-inch casing and 5 to 10 feet of stainless-steel screen. Jet pumps operated by small electric motors are common, and suction pumps are used in areas where water levels are near the surface.

Municipal wells generally are constructed with pit casings that range from 6 to 16 inches in diameter and well casings and screens that range from 4 to 10 inches in diameter. The lengths of screens range from 12 to 90 feet. Most of the wells are gravel packed to increase their effective diameter and to inhibit the inflow of fine sand. Deep-well turbine, submersible, jet, and airlift pumps are

used. More detailed information on the construction of individual wells is given in table 10.

CHEMICAL QUALITY OF GROUND WATER

Ground water contains dissolved matter because water acts as a solvent, and minerals of rocks and soils are soluble to some extent. Some of the chemical constituents and properties that are considered in the determination of the general suitability of water for most purposes are hydrogen-ion concentration (pH), iron, manganese, chloride, fluoride, and hardness.

Table 11 contains selected chemical analyses of water from wells in Sabine Parish, and the data are plotted in graph form on the map in plate 6. To facilitate comparison, the constituents are expressed in equivalents per million.

Most ground water in Sabine Parish is of the sodium bicarbonate type. During the movement of water from the recharge area the water is softened naturally by ion exchange—the exchange of calcium and magnesium ions in the water for sodium and potassium ions in the formation. As the water moves through the rocks the dissolved-solids content tends to increase; therefore, wells downdip yield more highly mineralized but softer water than wells updip in the same formation. Ground water may be contaminated by (1) unflushed salty connate water, (2) upward-moving brines leaking through faults, corroded oil-well casings, and loose plugs, or (3) downward percolation of disposed oil-field brines. The high concentrations of magnesium, calcium, sulfate, and chloride in water from well Sa-134 (table 11) possibly are due to contamination. Fluoride in 5 of the 30 samples listed in table 11 exceeds the rejection limit of 1.6 ppm (U.S. Public Health Service, 1962, p. 2154).

Highly mineralized, or "salty," water occurs at some depth in every Tertiary formation. The altitude of the base of fresh ground water in Sabine Parish ranges from more than 200 feet above sea level to more than 1,900 feet below sea level. Plate 7 is a map showing by contour lines the altitude of the base of fresh ground water in the parish.

Data from which the map was compiled were obtained from electrical logs of oil-test wells. In some areas, as in T. 7 N., R. 10 W., a transition zone occurs between water-bearing sands that contain fresh water and those that contain salty water. Within this zone, which may have a thickness of 500 feet or more, the water gradually becomes more mineralized with depth. Where water quality is estimated from electrical logs, it is difficult to determine with reasonabe accuracy the depth at which mineralization becomes prohibitive for fresh-water requirements. Where electrical logs are used to determine the base of fresh water, the base of the deepest sand or silt bed above a sand bearing obviously salty water is considered as the fresh water-salt water contact and is used as the basis for the contours on plate 7.

Because of faulting, the inclination of the fresh water-salt water interface in certain parts of Sabine Parish probably is much more nearly vertical than is indicated on the map. For these reasons the map should not be construed as an exact reflection of the base of fresh ground water, but it should serve as a reasonably reliable guide to the approximate extent of fresh water.

TEMPERATURE OF GROUND WATER

Collins (1925, p. 97) describes the normal ground-water temperature as "* * * in general about the same as the mean annual air temperature. Near the surface the temperature of the water follows the changes in air temperature; at greater depths the water has a higher temperature corresponding to the increase of the earth temperature with increasing depth." This increase in ground-water temperature has been determined to be 1°F with each 40 to 90 feet increase in depth (Stearns and others, 1937, p. 68).

The mean annual air temperature in Louisiana as recorded by the Weather Bureau for a 64-year period (1890-1954) is 67.1°. The temperature of water from wells in use in Sabine Parish ranges from 68° to 77° and averages about 70°F.

Ground water from a given depth is comparatively uniform in temperature, and that from shallow aquifers

is cooler than surface water in the summer. For these reasons it is generally more desirable than surface water for cooling in industrial processes.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

Ground-water supplies in Sabine Parish are obtained from formations that range in age from early Tertiary to Quaternary and represent the Wilcox and Claiborne Groups, the Catahoula Formation, and valley alluvium. The Tertiary formations crop out from north to south in the order in which they were deposited (see fig. 22), and the alluvium is in the stream valleys. The discussion of their water-bearing properties follows the same order.

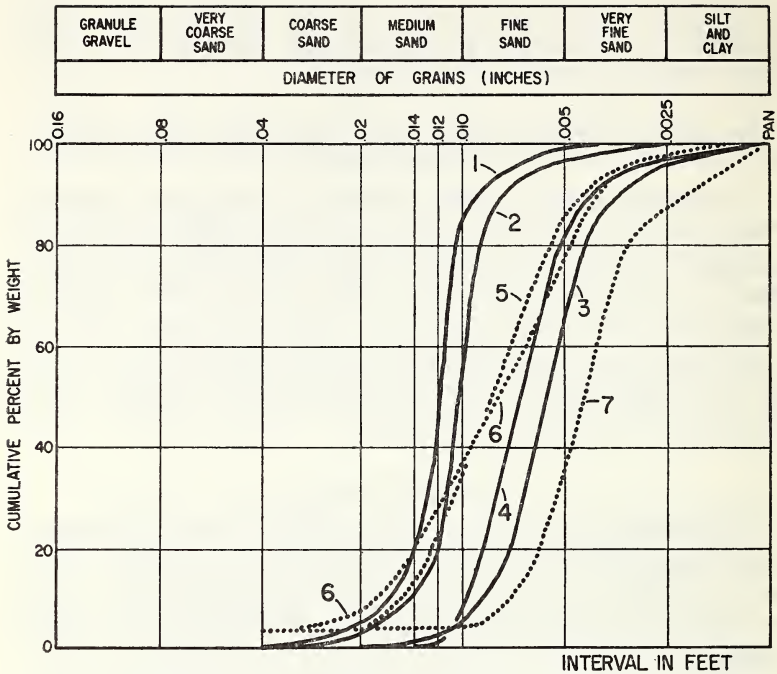
MIDWAY GROUP

The Midway Group in Sabine Parish is represented by the Kincaid Formation and the Porters Creek Clay. They are not known to contain sand beds and do not yield water to wells. All formations below the Kincaid contain salty water.

WILCOX GROUP

Owing to the large outcrop area of the Wilcox, it ranks as the most extensively tapped source of ground water in Sabine Parish. The water-bearing sands consist of clear quartz sand grains that are so interspersed with granular lignite as to give a dark-gray aspect. The sands are mostly very fine grained to medium grained. Size-analysis graphs of Wilcox sand samples from three wells are shown in figure 28. The thickness of individual sand beds, as indicated by drillers' logs and electrical logs, ranges from less than 5 to about 250 feet, and averages about 30 feet. The sands commonly are separated by clay beds that range in thickness from a few inches to more than 100 feet. (See table 12.) Because of the nonuniform thickness of individual beds their lateral extent is difficult to ascertain. The bedding and lenticularity of these rocks are shown on the east-west cross section (pl. 2).

The southward dip of the sediments causes individual sands to occur at ever-increasing depth toward the south.



CURVE	WELL & LOCATION	INTERVAL IN FEET BELOW LAND SURFACE
1	Sa-9	139-155
2	SEC. 19, T.10N.,R.11W.	175-215
3	Sa-292	335-345
4	SEC. 4, T.7N.,R.10W	375-385
5	J. J. BLAKE	234-260
6	NO.1 OIL TEST	295-315
7	SEC. 22, T.7N.,R.11W	387-407

Figure 28. Grain-size graphs of sands from the Wilcox Group.

Sands at the surface in the vicinity of Pleasant Hill (T. 10 N., R. 11 W.) are, if continuous, at depths approaching 3,000 feet below mean sea level at the southern boundary of the parish. (See fig. 24.)

Wilcox sands have generally low permeability (capacity to transmit water). A pumping test at Many, using a municipal well, indicated a field coefficient of permeability[1] of about 125 gpd (gallons per day) per square foot for sands

[1]The field coefficient of permeability (P_f) is the rate of flow of water in gallons per day through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot at the prevailing temperature of the water.

of the Wilcox. A test at Fort Jesup gave a field coefficient of permeability of about 60 gpd per square foot, and one at Zwolle gave 70 gpd per square foot. Values between the extremes have been obtained for sands of the Wilcox Group in other parishes of northwestern Louisiana.

Results of pumping tests made in Sabine Parish are shown graphically in figures 29-31. In all the tests observa-

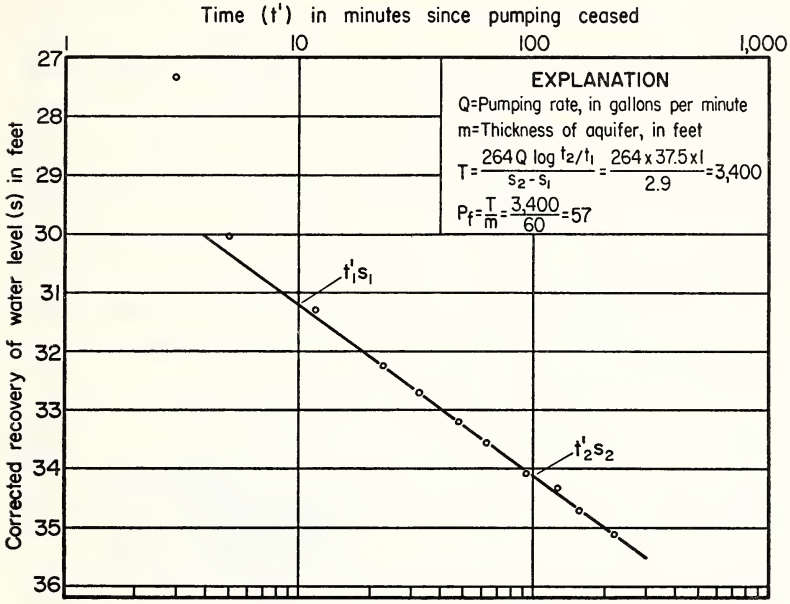


Figure 29. Semilogarithmic plot of water-level recovery in well Sa-292 at Fort Jesup, La.

tions were confined to the pumped well. By measuring the rate of water-level recovery after a period of pumping at a known constant rate, data are obtained that are used to construct the graphs. The value obtained is the coefficient of transmissibility (T) which is defined as the rate of flow of water, at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer 1 foot wide extending the full height of the aquifer under a unit hydraulic gradient. The coefficient of transmissibility is equivalent to the field coefficient of permeability multiplied by the thickness of the aquifer in feet.

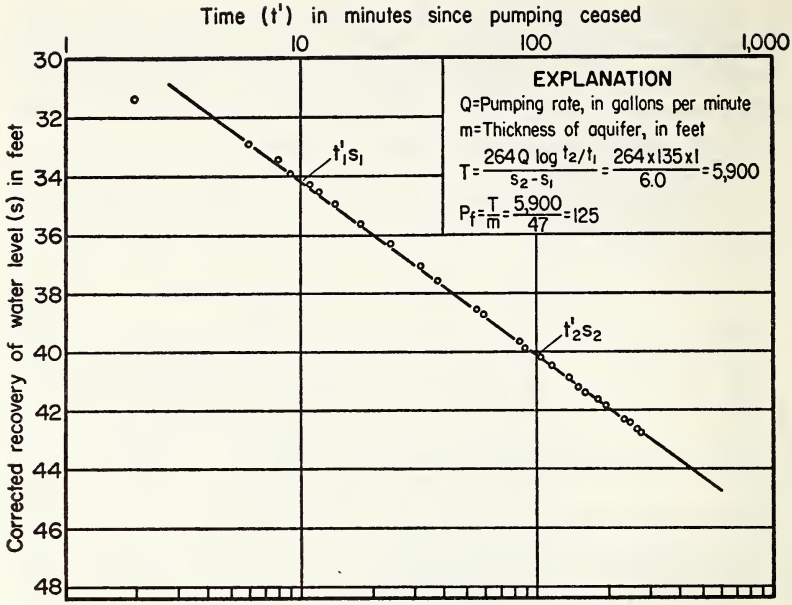


Figure 30. Semilogarithmic plot of water-level recovery in well Sa-294 at Many, La.

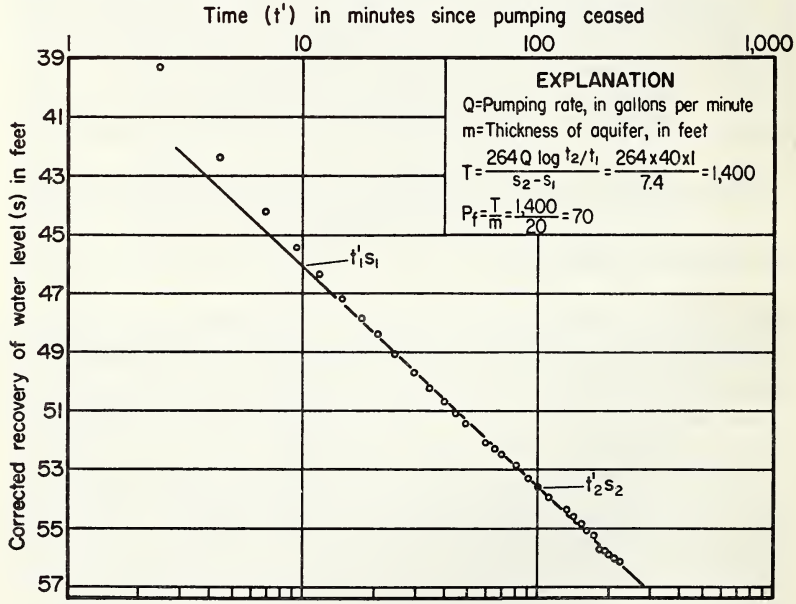


Figure 31. Semilogarithmic plot of water-level recovery in well Sa-342 at Zwolle, La.

In the tests at wells Sa-292, -294, and -342 measurements of both drawdown and recovery were obtained, but only recovery data, corrected for drawdown carryover, are on the graphs.

Sands in the Wilcox Group are recharged by rainfall in the outcrop areas and possibly by seepage through overlying clay where the clay is thin. The principal area of recharge is in the northern half of the parish where the regional structure and erosion have combined to expose sands at the surface. The thick clay of the overlying Cane River Formation makes it unlikely that the Wilcox sands receive much water from younger formations in the southern half of the parish. Water-level fluctuations in some shallow wells indicate a close correlation between precipitation and recharge. Water levels in deeper wells reflect precipitation generally on a seasonal basis. The hydrographs in figure 32 illustrate the relation of water-level

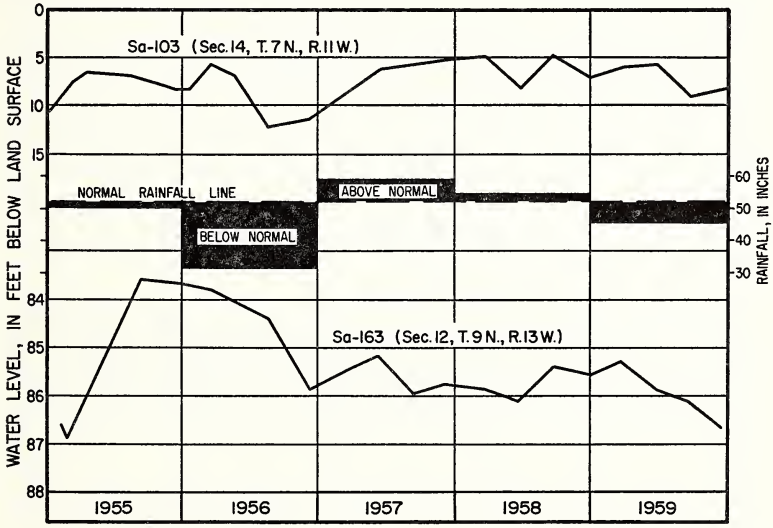


Figure 32. Hydrographs of wells screened in the Wilcox Group, with precipitation graph.

fluctuations in two deep wells in the outcrop area and precipitation.

Water in the Wilcox sands moves south and west from the recharge area and is discharged naturally by seeps and springs and by drainage into the alluvial fill of the larger

stream valleys. The Sabine River valley, which for three-quarters of its length in Sabine Parish is entrenched in rocks of the Wilcox Group, is a discharge area for water in these sands. In wells drilled through the mantle of alluvium and into Wilcox sands water rises only to the general level of that in wells screened in the alluvium. This water level is considerably lower than water levels in wells yielding from the Wilcox in the highlands, indicating that the alluvial valleys serve as drains for the Wilcox sands. The Wilcox discharges water artificially by means of the many wells in the northern half of the parish. As none of the wells have large yields they exert little influence on the general movement of water in the sands.

The largest ground-water withdrawals in Sabine Parish have been made in the municipal well field at Many. Reported static water levels were 154 feet above sea level before development of the well field in 1931. By 1955 water levels in the field were only about 100 feet above sea level and in 1959 reported water levels were about 85 feet above sea level. In 1959 a new well (Sa-294) was installed about 4,000 feet northwest of the main well field. The water level in this well was 127 feet above sea level, indicating the widespread effects of pumping at Many over a period of 28 years. A profile which illustrates the effects of pumping is shown in figure 33. On the profile the shaded area is the drawdown of the piezometric surface.

Water wells in the Wilcox are of the dug and rotary-drilled types. The depths of dug wells rarely exceed 40 feet and average about 25 feet. The depths of drilled wells range generally from 100 to 500 feet and average about 230 feet. Most of the drilled wells contain 4-inch casing and 10 to 15 feet of screen having 0.014-inch openings. They are equipped either with jet or submersible centrifugal pumps.

Most wells in the Wilcox sands are constructed to yield quantities of water adequate for domestic and small farm supplies. The only attempts to obtain large supplies have been made by the towns of Many and Pleasant Hill. At Many a yield of 145 gpm is obtained from well Sa-294. In a test of this well a drawdown of 44 feet resulted from pumping 135 gpm for a period of 4 hours. The specific

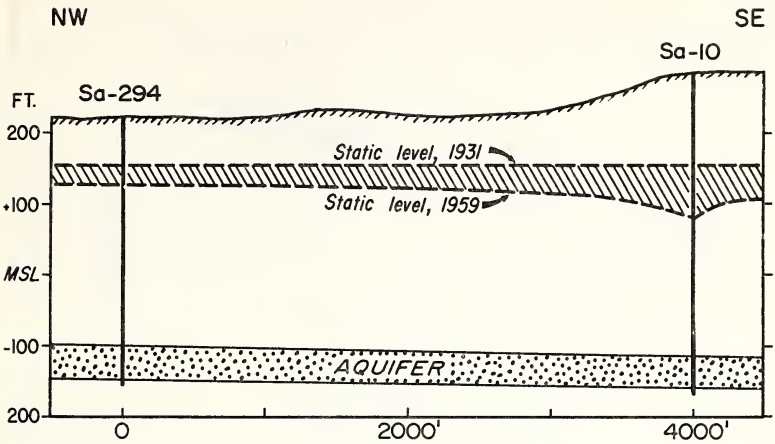


Figure 33. Water-level profile showing effects of pumping at Many, La.

capacity[2] was 3.1 gpm per foot of drawdown at the end of the pumping period. At Pleasant Hill well Sa-248 (sec. 29, T. 10 N., R. 11 W.), which yields 140 gpm in normal operation, was tested for 24 hours at yields which ranged from 106 to 250 gpm. The resultant specific capacity was 6 gpm per foot of drawdown. Well Sa-342, at Zwolle, was pumped at the rate of 40 gpm for 24 hours, and the specific capacity was 0.7 gpm per foot of drawdown. Well Sa-292, at Fort Jesup State Park, had a specific capacity of 1 gpm per foot after pumping 38 gpm for 24 hours. Well Sa-215 (sec. 6, T. 7 N., R. 12 W.), near Zwolle, reportedly yields 85 gpm, but drawdown data are not available. The rather wide range in specific capacities among the wells described is the result of differences in (1) sand thickness and permeability, (2) well construction and development, and (3) well condition.

The town of Many obtains its municipal water supply from six Wilcox wells (Sa-2, -3, -10, -11, -288, -294) located as shown on the map in figure 34. Wells Sa-3 and -288 are screened in sands that occur between the depths of 190 and 260 feet below the surface in the main well-field area. The other four wells are screened in a sand that occurs between

[2]Specific capacity is defined as the unit yield per foot of drawdown for a given period of time. It is usually expressed in gallons per minute per foot of drawdown.

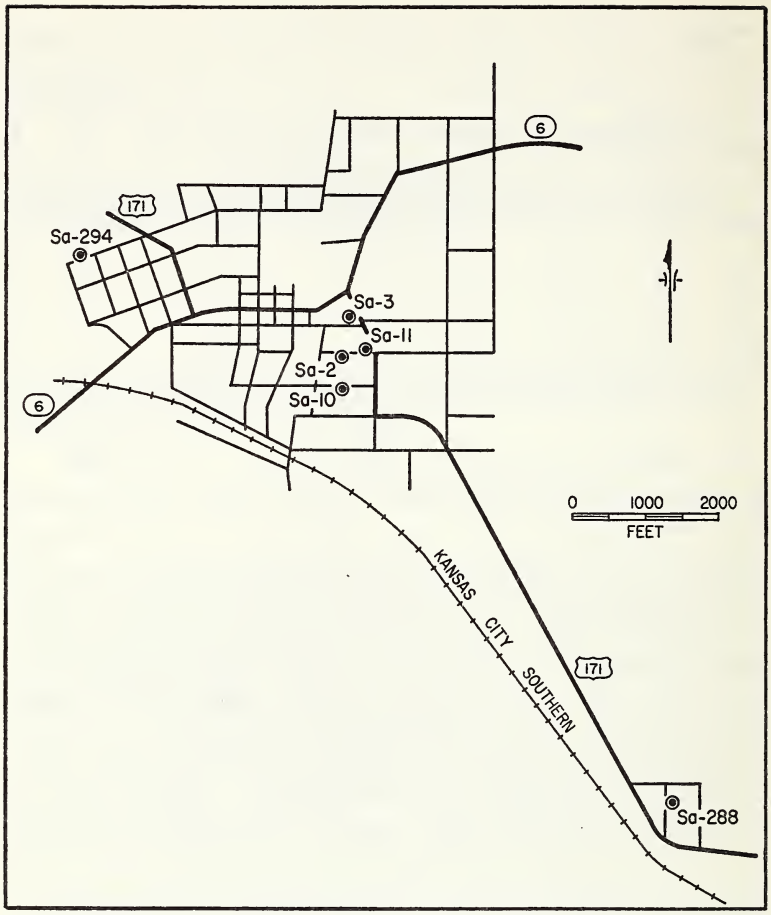


Figure 34. Map of Many, La. showing location of municipal water wells.

the depths of 400 and 450 feet in the same field. The following table contains comparative data on the municipal wells at Many.

USGS well no.	Owner's no.	Year drilled	Depth (feet)	Diameter (inches)	Screened interval	Screen opening (inches)	Type of pump	Yield (est. 1959) (gpm)
2	2	1931	450	6	404-450	.018	Turbine	90
3	1	1927	250	?	?-250	?	Turbine	120
10	3	1950	450	8	404-444	.009	Turbine	90
11	4	1950	448	8 ⅝	412-448	?	Turbine	50-60
288	5	1957	368	3	296-320 334-342 350-368	?	Turbine	20
294	6	1959	373	6	343-373	.016	Turbine	145

In 1959 municipal pumpage at Many averaged about 200,000 gpd, although the maximum was about 400,000 gpd.

Pleasant Hill obtains a municipal supply from one well in the Wilcox (Sa-248), which is 502 feet deep. The yield of this well in 1959 was 140 gpm. Average pumpage in 1959 was about 40,000 gpd and the maximum was 50,000 gpd. Zwolle has three wells in the Wilcox (Sa-182, -183, -342), 205 to 225 feet deep, which together yield about 100 gpm and supply a population of about 1,700.

At Converse two privately owned wells in the Wilcox (Sa-13 and -350), which yield 20 gpm each, supply a population of 400. The wells are 250 feet deep and constructed similarly. One well is pumped constantly; the other is pumped 12 hours per day. Pumpage averages 42,000 gpd.

The chemical quality of water in the Wilcox sands is indicated by the analyses in table 11 and illustrated by bar graphs in plate 6. The water is a sodium bicarbonate type, and generally is soft (hardness less than 60 ppm), although in some places it is very hard (hardness greater than 200 ppm). Water from most of the wells has an iron content greater than the maximum recommended by the U.S. Public Health Service for drinking water. Sulfate and chloride contents generally are below recommended limits, but the fluoride content commonly is greater than the recommended limit of 1.6 ppm; an unusually high value (11 ppm) was measured in the water from well Sa-295 (sec. 2, T. 6 N., R. 11 W.). In 13 of 20 listed analyses of water from the Wilcox the dissolved solids content is greater than 500 ppm and in 4 analyses it is greater than 1,000 ppm. Color, derived probably from granular lignite in the sands, is noticeable in water from many wells, particularly in the southern half of the Wilcox outcrop area.

Salty water in the Wilcox Group is found at depths that range from about 200 feet above sea level to more than 800 feet below sea level. As shown by the contour lines on plate 7 the altitude of the base of fresh ground water ranges greatly throughout Sabine Parish; therefore, it is difficult to predict accurately the maximum depth of fresh-water occurrence to any specified location.

Measured temperatures of water from Wilcox wells range from 68° to 77°F.

CLAIBORNE GROUP

Carrizo Sand

The Carrizo Sand is not as important hydrologically in Sabine Parish as it is in neighboring areas to the east and west, because of the effects of faulting. Much of the Carrizo, along with the Cane River Formation and possibly upper beds of the Wilcox Group, has been removed from the surface in this parish, and in the shallow subsurface it abuts older and younger formations. South of the intensely faulted zone the Carrizo is relatively untapped because of the availability of water at shallower depth in the Sparta Sand, and because the sand contains salty water within a short distance of the fragmentary outcrop.

Where available in its full thickness the Carrizo consists of slightly more than 100 feet of clean, very fine-to medium-grained sand in massive beds. The permeability, which averages 200 gpd per square foot in areas outside of Sabine Parish, is substantially greater than that of the Wilcox sands.

The Carrizo Sand doubtlessly is tapped by some of the wells in Sabine Parish. However, because of the generalized nature of the data that are available on the many low-yielding wells, and because of the complexity of the faults in the outcrop area, it is nearly impossible to state that a well is yielding from the Carrizo Sand rather than from the Wilcox Group or Sparta Sand. At present no substantial industrial or municipal supplies are obtained from the Carrizo Sand.

Cane River Formation

The Cane River Formation is composed of clay and marl and does not yield water to wells.

Sparta Sand

The Sparta Sand is the most important aquifer in northern Louisiana, and although large quantities of water are obtained from it in several other parishes, it has been tapped only slightly in Sabine Parish. Sands in the Sparta are generally lighter in color and coarser than sands of the

Wilcox Group. Individual sands range in thickness from 10 to 60 feet and are separated by 5 to 30 feet of clay.

Because of regional dip, the beds of the Sparta Sand in the outcrop area are below a depth of 1,800 feet near the southern boundary of the parish and below 2,300 feet near the southeastern boundary.

Although hydraulic characteristics have not been determined for the Sparta Sand in Sabine Parish, pumping tests elsewhere in northern Louisiana indicate a greater permeability for the Sparta than for the Wilcox sands. Values obtained for the Sparta range between 225 and 320 gpd per square foot. Conditions relating to recharge, movement, and discharge of water from the Sparta are similar to those described for the Wilcox.

Wells screened in the Sparta are either dug or drilled. Drilled wells range in depth from 90 to 280 feet. A lumber mill and its community at Fisher obtain a water supply from six closely spaced wells 100 feet in depth (see well Sa-8 in table 10) and constructed with 7-, 8-, or 10-inch casing and 20 feet of screen. Two of the wells are pumped by compressed air, one by jet pump, and three by turbine pumps. The wells are reported to yield 40 gpm each and to have a specific capacity of about 2 gpm per foot of drawdown after one-half day of pumping. Well Sa-242, which is 3 miles northeast of Fisher, also yields 40 gpm from the Sparta. This well is 90 feet deep, has 6-inch casing and 20 feet of screen, and is equipped with a jet pump. Drawdown data are not available.

Water in the Sparta Sand is reported by well owners to range from soft to hard and to contain high iron concentrations. Analyses of water from five wells in the Sparta (Sa-8, -31, -303, -308, -349) are given in table 11 and illustrated on plate 6. Water from the Sparta Sand is of good quality except for a high iron content which, in well Sa-8, is reduced by aeration. Water from well Sa-242 (sec. 17, T. 6 N., R. 10 W.) is treated to reduce both hardness and iron content. At distances more than 3 or 4 miles south of the outcrop area the Sparta contains salty water where the formation dips farther below the land surface.

Cook Mountain Formation

The Cook Mountain Formation is not considered to be an aquifer. The formation is mostly clay, but in places contains thin beds of sand. The sands are discontinuous and have a fine-grained texture and gray color. Regional dip places the base of the Cook Mountain beds 2,700 feet below the land surface in the extreme southern part of Sabine Parish.

All wells recorded in the Cook Mountain Formation in this investigation are dug wells less than 35 feet deep.

Cockfield Formation

The sandy character and the thickness of the Cockfield Formation suggest its potential importance as a water-bearing formation in Sabine Parish. Sands in the Cockfield are lignitic and range in texture from very fine to medium grained. Drillers' logs and electrical logs indicate that the sand beds range in thickness from 5 to 55 feet and average 25 feet. Clay beds that range from 10 to 30 feet in thickness separate the sands. Like the other Tertiary formations the Cockfield dips southward, and its base descends from its outcrop in the vicinity of Florien to 1,700 feet below the surface at the southern boundary of the parish.

Little is known about the permeability of Cockfield sands in Sabine Parish, but descriptions in drillers' logs indicate no major differences between them and sands of the other formations in the Claiborne Group. General conditions of ground-water occurrence probably are similar to those for the Wilcox, Carrizo, and Sparta beds.

Available records indicate no large-capacity wells in sands of the Cockfield, but dug and drilled wells are used for domestic and farm supplies. The drilled wells range in depth from 60 to 600 feet and contain 2- or 4-inch casing and 6 to 25 feet of screen. They are equipped with jet or submersible centrifugal pumps.

Analyses in table 11 and plate 6 show the chemical quality of water from three wells in the Cockfield (Sa-213, -310, -321). A wide variation in the quality of the water is apparent. Well Sa-310, which is nearly 600 feet deep, yields

water that contains little other than sodium bicarbonate as dissolved solids. Water from each of the other two wells, which are less than 200 feet deep, is hard and contains high concentrations of iron.

Fresh water is found at greater depth in the Cockfield than in any other formation in Sabine Parish, according to electrical logs of oil-test holes in T. 4 N., R. 11 W. The logs indicate that sands more than 1,300 feet below sea level contain fresh water. (See pl. 3.) The extent of the area in which fresh water occurs at such great depth is not known; however, a similar deep fresh-water occurrence in the Cockfield has been observed in Natchitoches Parish. In the western part of the Cockfield outcrop area fresh water is at least 200 feet below sea level (400 feet below the land surface); in the eastern part of the outcrop the base of fresh water is about 100 feet higher.

JACKSON AND VICKSBURG GROUPS

The Jackson and Vicksburg Groups are not considered to be aquifers in Sabine Parish, although a sporadic sand bed in the base of the Vicksburg may in places yield enough water for small domestic or farm supplies. The Jackson contains a few thin beds of sand, but they yield bad-tasting water. In the outcrop areas wells have proved inadequate and nearly all water supplies are obtained from aboveground cisterns. A hole drilled to a depth of 400 feet (Sa-43) in sec. 31, T. 5 N., R. 10 W. failed to penetrate a water-yielding sand in the Jackson.

MIOCENE BEDS

Catahoula Formation

The Kisatchie Wold, which marks the outcrop of the Catahoula Formation (of Miocene(?) age), is a sparsely inhabited upland where little development of ground-water supplies has been undertaken. Water-bearing strata consist of clear quartz sand which ranges widely in grain size but generally is coarser than sands of Eocene age. The thickness of the sand beds, as indicated by drillers' logs and electrical logs, ranges from 10 to 100 feet and averages 50 feet. Sands are separated by 10-to 100-foot clay beds. All sands dip to

the south but, as the Vernon Parish line is only 2 to 3 miles south of the Catahoula outcrop, the upper sands do not dip lower than 300 feet below the surface in Sabine Parish.

Mechanical analyses of sand samples indicate that sands in the Catahoula are coarser and less uniform in grain size than sands in the Claiborne and Wilcox Groups. Pumping tests that have been made outside of Sabine Parish indicate that the permeability of sands in the Catahoula is higher than that of sands in the Wilcox and equal to or higher than that of the Claiborne Group sands. The Catahoula Formation is recharged in the outcrop area by precipitation that moves downgradient and laterally to storage in the ground-water reservoir and to points of discharge.

Water supplies are obtained from the Catahoula by means of dug and drilled wells. The drilled wells range in depth from 100 to 300 feet. Most of them are constructed with 4-inch casing and as much as 20 feet of screen, and are equipped with jet or submersible turbine pumps.

Chemical analyses of water from two wells (Sa-228 and -287) in the Catahoula are given in table 11 and illustrated in plate 6. The water is soft and low in dissolved-solids content (less than 500 ppm), but the iron content is above the maximum recommended for drinking water. Water from the Catahoula commonly is high in iron in the adjoining parishes of Natchitoches and Vernon. Data on the depth of occurrence of fresh ground water in the Catahoula are scarce, but electrical logs indicate fresh water in the formation at depths 600 to 700 feet below the surface in T. 3 N., R. 12 W. and T. 4 N., R. 11 W.

PLEISTOCENE AND RECENT DEPOSITS

Deposits of Pleistocene age occur as terrace remnants along stream valleys. They consist chiefly of fine- to coarse-grained sand intermixed with gravel. Maximum thicknesses approach 100 feet. The deposits are highly dissected, but locally they may be extensive enough to yield adequate quantities of water for domestic and stock purposes. Where present they function as a conduit for water from the Tertiary sands in the uplands to the alluvium of the stream valleys.

Alluvium underlying the flood plain of the Sabine River may represent both Pleistocene and Recent deposition, depending upon whether or not the river removed all Pleistocene material during its last period of down-cutting. Test holes in the Sabine River valley yielded data from which the cross section in figure 35 was constructed. Logs

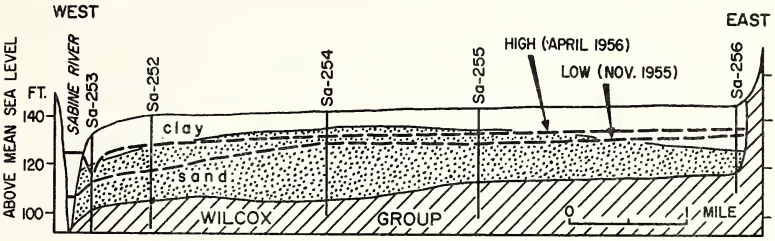


Figure 35. Cross section (T. 6 N., R. 13 W.) of Quaternary deposits and high and low water levels in the Sabine River valley.

of the test holes, given in table 13, show that the water-bearing sand ranges from fine to coarse. The changes in texture are generally gradational, the coarser material being at the bottom. Analyses of formation samples from test holes Sa-228 and -271 indicate that the alluvial deposits are composed of medium-to coarse-grained sand. The sand is gray or brown; gray is more common in the coarse material. Boring records indicate that sand thicknesses in the valley range from 10 to 40 feet. Alluvium deposited in Recent time in the small stream valleys tributary to the Sabine River valley is thin and contains a high proportion of clay and silt.

The alluvium is recharged by the downward seepage of rainfall in the valley and by lateral and upward movement of water from the Tertiary formations that form the walls and floor of the entrenched valley. As in the Red River Valley to the east, the Sabine River valley functions as a drain for the Tertiary sands that are recharged by rainfall in the highland areas. Water in the alluvium is under water-table conditions except in some areas where a clay mantle acts as a confining bed and induces locally artesian conditions.

Movement of water in the alluvial sand is mainly to-

ward the Sabine River where it is discharged. The hydraulic gradient, at times of high and low stream stage, is indicated on the valley cross section in figure 35. Some movement probably occurs down the valley within the sand. Hydrographs in figure 36 show seasonal fluctuations in ground-

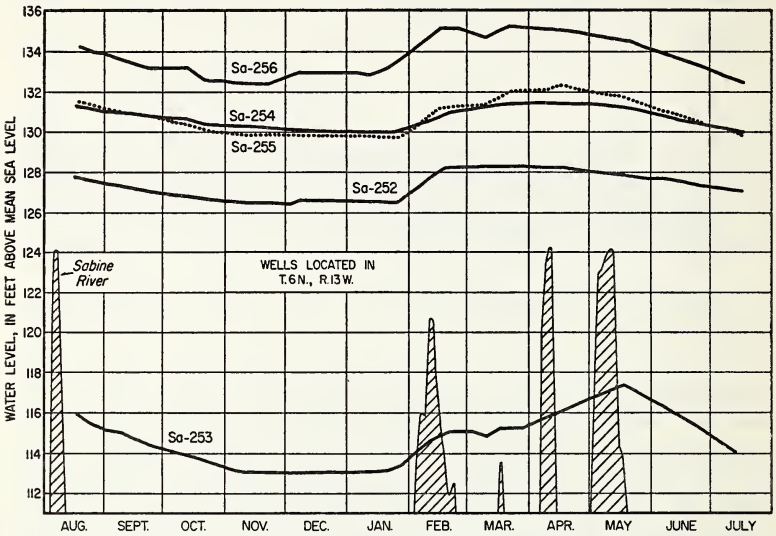


Figure 36. Hydrographs of wells in the Quaternary alluvium and Sabine River high stages, 1955-56.

water and stream levels. At times of high stream stage, such as periods in February, April, and May 1956, the normal hydraulic gradient is reversed adjacent to the streams, a ground-water trough is formed, and surface water enters the aquifer. Unless the streams remain at high stage for prolonged intervals the reversal of the gradient does not reach far from the streams, probably no more than a few hundred yards.

Only low-yielding domestic and stock wells have been developed in the alluvial aquifer. Dug and driven wells are rarely more than 20 feet deep. Drilled wells generally penetrate the sand, and in places are 50 to 60 feet deep. Most of them contain 4-inch casing and 10 to 15 feet of screen or slotted casing, and are equipped with bailer buckets or shallow-well electric pumps.

The chemical quality of the water is reported to be

good; it is soft and has an unobjectionable iron content. The water would be expected to vary in chemical composition and temperature in places closely adjacent to the streams during and immediately after periods of such high stream stage that water flows into the aquifer. The same effect might be produced by heavy withdrawals from the alluvium at points where the lowering of ground-water levels is sufficient to induce flow from nearby streams.

DEVELOPMENT OF GROUND-WATER RESOURCES

The ground-water resources of Sabine Parish are relatively undeveloped. Water-bearing formations known to be intensively developed aquifers elsewhere in northern Louisiana are covered in southern Sabine Parish by sparsely populated timberland. Most of the population and industry are in the northern two-thirds of the parish where ground-water supplies are obtained from sands of the Wilcox Group. The Wilcox sands vary greatly in thickness and texture and are not everywhere capable of yielding large or even moderate quantities of water to wells. However, domestic and farm supplies are obtained without difficulty, and municipal supplies have been developed at scattered points. With careful exploration programs supplies adequate for small industrial and municipal uses may be found available in areas where heretofore the Wilcox has undergone development only for domestic and farm supplies.

The Sparta, Cockfield, and Catahoula Formations constitute the virtually untapped aquifers in southern Sabine Parish. The ruggedness of the topography has discouraged transportation, agriculture, and industry; hence the need for water supplies has not been pressing. If this area is considered for development ground-water resources of the formations mentioned probably will receive much attention.

Evidence obtained in this investigation indicates that the alluvial sands in the valleys of the Sabine River and other streams are of little potential importance as sources of ground-water supplies. The thinness, irregularity, and fine texture of these sands restrict their development to low-yield farm and home-supply wells.

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BASIC DATA

Tables 1-20

TABLE 1. SUGGESTED WATER-QUALITY TOLERANCES IN INDUSTRY (CALIFORNIA STATE WATER POLLUTION CONTROL BOARD, 1952)

(Allowable limits in parts per million)

Industry or use	Turbidity	Color	Hardness as $CaCO_3$	Iron (Fe)	Manganese (Mn)	Iron and manganese	Dissolved solids	Alkalinity as $CaCO_3$	Odor (taste)	Hydrogen sulfide	Other requirements[1]
Air conditioning	.....	.....	.....	0.5	.....	.....	.....	.....	Low	.....	No corrosiveness, slime formation.
Baking	10	10	.....	.2	.....	.....	.....	.....	Low	0.2	Potable water.[2]
Brewing:											
Light beer	1–10	.....	200–300	.1–1.0	.....	.....	500	75–80	Low	.2	Potable water.[2] NaCl less than 275 ppm (pH 6.5–7.0).
Dark beer	1–10	.....	200–300	.1–1.0	.....	.....	1,000	80–150	Low	.2	Potable water.[2] NaCl less than 275 ppm (pH 7.0 or more)
Canning:											
Legumes	10	.....	25–75	.2	0.2	0.2	.....	.....	Low	1	Potable water.[2]
General	10	.....	50–85	.2	.2	.2	.....	.....	Low	1	Potable water.[2]
Carbonated beverages	1–2	5–10	200–250	.1–.2	.2	.2	850–855	30–170	Low	0.0–.2	Potable water.[2] Organic color plus oxygen consumed less than 10 ppm.
Confectionery	.....	.....	.....	.2	.2	.2	100	.....	Low	.2	Potable water.[2] pH above 7.0 for hard candy.
Cooling	50	.....	50	.5	.5	.5	.....	.....	Low	.....	No corrosiveness, slime formation
Food, general	10	10	50–85	.2–.3	.2	.2	.....	30–250	Low	.....	Potable water.[2]
Ice	1–5	5	70–72	.03–.2	.2	.2	.....	30–50	Low	.....	Potable water.[2] SiO_2 less than 10 ppm.
Laundering (diapers)	.....	.....	0–50	.2	.2	.2	.....	60	.....	.....	Potable water.[2]
Plastics, clear uncolored	.....	.....	.....	.02	.02	.02	200	.....	.....	.....	
Paper and pulp:											
Groundwood	50	≦35	200	.3	0	1.0	500	150	.....	.....	No grit, corrosiveness.
Kraft pulp	.....	≦25	100	.2	.1	.2	500	150	.....	.....	
Soda and sulfite	.....	10	100	.1	.05	.1	250	75	.....	.....	
High-grade light papers	5–25	≦5	100	.1	.05	.1	200	45–75	.....	.....	
Rayon (viscose), pulp production	.....	5	8	0–.05	.03	.05	100–200	.....	.....	.....	Al_2O_3 less than 8 ppm, SiO_2 less than 24 ppm, Cu less than 5 ppm.
Manufacture	.....	.....	50–55	0	0	0	.....	.....	.....	.....	pH 7.8 to 8.3.
Tanning	20	10–100	50–135	.1–2.0	.2	.2	.....	135	.....	.....	
Textiles:											
General Dyeing	.....	5–70	.....	.....	.25	.25	.....	.....	.....	.....	Constant composition. Residual alumina less than 0.5 ppm.
Wool scouring	.....	.....	.....	.....	1.0	1.0	.....	.....	.....	.....	
Cotton bandage	.....	.....	.....	.....	.2	.2	.....	.....	Low	.....	

[1]After Moore, E. W., 1940, p. 271.
[2]Conforming to U. S. Public Health Service standards.

TABLE 2. MISCELLANEOUS LOW-FLOW MEASUREMENTS

Index No.	Stream	Location	Drainage Area (sq. mi.)	Date	Discharge in cubic feet per second	Discharge for same day	
						Bayou LaNana near Zwolle, La.	Bayou San Patricio near Noble, La.
4	Bayou Scie	at Zwolle, La.	45.9	Sept. 29, 1954	no flow	.....	no flow
				Sept. 28, 1956	no flow	no flow	no flow
				Aug. 5, 1957	no flow	1.0	0.7
				Apr. 7, 1958	9.17	22	42
				June 5, 1958	3.04	12	4.5
				July 24, 1958	3.40	6.2	7.0
				Aug. 21, 1958	.01	1.2	.6
				Nov. 4, 1958	.40	7.2	3.7
6	Lewis Creek	near Many, La.	12.5	Sept. 29, 1954	no flow	.....	no flow
				Sept. 28, 1956	no flow	no flow	no flow
				Aug. 5, 1957	no flow	1.0	0.7
				Apr. 7, 1958	1.78	22	42
				July 24, 1958	.66	6.2	7.0
				Aug. 21, 1958	.01	1.2	.6
				Nov. 4, 1958	.12	7.2	3.7
7	Bayou Negreet	near Negreet, La.	52.1	Oct. 7, 1955	no flow	1.2	3.1
				Oct. 25, 1955	1.13	.4	1.6
				Aug. 13, 1956	.057	.4	no flow
				Sept. 28, 1956	.002	no flow	no flow
				Oct. 20, 1956	.103	no flow	no flow
				June 6, 1958	5.92	6.2	3.7
				Nov. 7. 1958	6.63	7.8	3.7
11	Little Bayou San Miguel	near Mitchell, La.	33.4	Sept. 28, 1956	no flow	no flow	no flow
				Aug. 5, 1957	no flow	1.0	0.7
				Apr. 7, 1958	5.52	22	42
				June 5, 1958	.98	12	4.5
				Nov. 4, 1958	.077	7.2	3.7
14	Bayou Santabarb	at Bellwood, La.	51.1	Sept. 29, 1954	0.043	.....	no flow
				Sept. 27, 1956	no flow	no flow	no flow
				Oct. 20, 1956	.037	no flow	no flow
				Aug. 12, 1957	.94	1.0	.5
				Apr. 7, 1958	17.9	22	42
				June 11, 1958	2.86	5.0	10
				July 2, 1958	4.11	14	13
				Dec. 5, 1958	4.91	7.2	25
15	Middle Creek	near Bellwood, La.	40.0	Sept. 28, 1956	no flow	no flow	no flow
				Aug. 12, 1957	2.18	1.0	.5
				Apr. 7, 1958	14.3	22	42
				June 11, 1958	2.87	5.0	10
				July 2, 1958	6.35	14	13
				Dec. 5, 1958	4.88	7.2	25
16	Bayou San Patricio	near Benson, La.	81.1	Sept. 29, 1954	no flow	.....	no flow
				Aug. 14, 1955	4.16	.....	6.8
				Sept. 22, 1955	.2 (est.)	.....	2.7
				Apr. 4, 1956	6.29	11	17
				Aug. 15 1956	no flow	.1	no flow
				Dec. 3, 1956	no flow	.4	.1
				Aug. 5, 1957	.105 (est.)	1.0	.7
				June 5, 1958	2.89	12	4.5
				Nov. 4, 1958	1.90	7.2	3.7
17	Clement Creek	near Hunter, La.	44.6	Sept. 26, 1956	no flow	no flow	no flow
				Dec. 3, 1956	.040	.4	.1
				Aug. 5, 1957	.98	1.0	.7
				Feb. 5, 1958	12.8	46	29
				Apr. 8, 1958	8.56	19	34
				Nov. 5, 1958	1.95	7.5	3.7

TABLE 2. MISCELLANEOUS LOW-FLOW MEASUREMENTS—Cont.

Index No.	Stream	Location	Drainage Area (sq. mi.)	Date	Discharge in cubic feet per second	Discharge for same day	
						Bayou LaNana near Zwolle, La.	Bayou San Patricio near Noble, La.
18	Cow Bayou	near Hunter, La.	29.2	Sept. 26, 1956	no flow	no flow	no flow
				Dec. 3, 1956	no flow	.4	.1
				Aug. 5, 1957	no flow	1.0	.7
				Feb. 5, 1958	6.61	46	29
				Apr. 8, 1958	4.87	19	34
				June 5, 1958	.916	12	4.5
				Nov. 5 1958	.326	7.5	3.7
19	Bayou Toro	south of Toro, La.	187	Oct. 25, 1955	9.20	.4	1.6
				Oct. 20, 1956	.657	no flow	no flow
				Aug. 13, 1957	9.94	1.2	.4
				June 12, 1958	19.2	4.1	6.7
				Aug. 21, 1958	8.44	1.2	.6

TABLE 3. MAXIMUM STAGES AND DISCHARGES FOR EACH WATER YEAR FOR PERIOD OF RECORD FOR SABINE RIVER AT LOGANSPORT, LA.

Water Year	Date	Gage height[1] (feet)	Water-surface elevation (feet above mean sea level)[1]	Discharge (cfs)
1884	May, 1884	39.4	187.1	60,000
1904	Apr. 13, 1904	18.6	166.3	6,090
1905	May 26, 1905	33.8	181.5	33,600
1906	Jan 5, 1906	29.6	177.3	20,000
1907	May 31, 1907	24.5	172.2	10,800
1908	May 18, 1908	32.9	180.6	30,100
1909	Feb. 19, 20, 1909	19.0	166.7	6,330
1910	Mar. 24, 25, 1910	20.8	168.5	7,540
1911	Apr. 29, 1911	20.0	167.7	6,980
1912	Apr. 9, 1912	27.7	175.4	16,200
1913	Mar. 18, 1913	25.5	173.2	11,900
1914	May 10, 1914	34.4	182.1	36,000
1915	May 5, 1915	36.9	184.6	47,000
1916	Feb. 3, 1916	26.4	174.1	13,800
1917	Mar. 11, 12, 1917	16.8	164.5	5,100
1918	May 11, 1918	22.5	170.2	8,890
1919	Jan. 6, 1919	24.4	172.1	10,700
1920	Jan. 27, 1920	33.3	181.0	31,600
1921	Apr. 29, 1921	35.7	183.4	41,600
1922	Apr. 2, 1922	33.6	181.3	32,800
1923	Apr. 8, 1923	25.9	173.6	12,200
1924	Dec. 26, 1923	27.2	174.9	14,000[2]
1925	May 25, 1925	12.24	159.96	3,100
1926	Apr. 5, 1926	29.6	177.3	23,000
1927	Apr. 19, 1927	29.1	176.8	20,900
1928	Apr. 29, 1928	22.4	170.1	9,860
1929	June 1, 1929	....[3]	.....	25,000
1930	May 29, 1930	34.1	181.8	34,800
1931	May 4, 1931	24.6	172.3	10,800
1932	Feb. 23, 1932	35.6	183.3	41,100
1933	July 25, 1933	34.6	182.3	29,400[4]
1934	Mar. 8, 1934	28.4	176.1	17,400
1935	May 8, 1935	34.4	182.1	36,000
1936	Dec. 14, 1935	21.7	169.4	8,400
1937	Jan. 29, 1937	24.6	172.3	11,800
1938	Feb. 7, 1938	31.6	179.08	25,700
1939	Mar. 4, 1939	25.98	173.70	13,600
1940	Feb. 11, 1940	23.28	171.00	8,060[5]
1941	Nov. 27, 1940	35.91	183.63	38,800
1942	Apr. 24, 1942	31.98	179.70	27,000
1943	June 21, 1943	33.40	181.12	31,400
1944	May 6, 1944	35.05	182.77	34,300
1945	Apr. 8, 1945	44.07	191.79	92,000
1946	June 13, 1946	35.15	182.87	37,000
1947	Nov. 22, 1946	32.17	179.89	25,400
1948	Feb. 15, 16, 1948	25.16	172.88	13,200
1949	Mar. 16, 1949	21.08	168.80	9,380
1950	Feb. 25, 1950	32.70	180.42	28,900
1951	Feb. 22, 1951	18.75	166.47	7,620
1952	Feb. 17, 1952	24.00	171.72	13,000
1953	May 19, 1953	35.98	183.70	40,900
1954	May 18, 1954	23.47	171.19	11,500
1955	Apr. 18, 1955	24.60	172.32	12,600
1956	May 8, 1956	25.70	173.42	13,800
1957	May 7 1957	39.41	187.13	61,300
1958	May 10, 11 1958	37.82	185.54	51,300

[1]Gage heights and water-surface elevations are for site of present supplementary gage at bridge on U. S. Highway 84.

[2]Occurred June 3, 4, 1934, gage height 26.90 feet.

[3]No gage height record; discharge computed on basis of record for stations near Longview and near Bon Wier.

[4]Occurred July 27, 1933, gage height, 32.7 feet.

[5]Occurred Feb. 7, 1940, gage height, 20.57.

TABLE 4. MAXIMUM STAGES AND DISCHARGES FOR EACH WATER YEAR FOR PERIOD OF RECORD FOR SABINE RIVER AT MILAM, TEXAS

Water Year	Date	Gage height (feet)	Water-surface elevation (feet above mean sea level)	Discharge (cfs)
1939	Feb. 20, 1939	31.68	129.64	17,700
1940	Feb. 12, 1940	34.55	132.51	20,300
1941	Nov. 29, 1940	44.70	142.66	54,200
1942	Nov. 5, 1941	38.42	136.38	25,100
1943	July 1, 1943	33.91	131.87	21,700
1944	May 7, 1944	45.33	143.29	52,700
1945	Apr. 12, 1945	48.87	146.83	83,400
1946	Feb. 12, 1946	42.56	140.52	36,400
1947	Jan. 20, 1947	36.78	134.74	22,300
1948	Feb. 15, 16, 1948	31.84	129.80	18,800
1949	Mar. 29, 1949	30.37	128.33	17,400
1950	June 5, 1950	43.42	141.38	42,400
1951	Mar. 30, 1951	29.14	127.10	16,100
1952	Apr. 25, 1952	30.12	128.08	17,000
1953	May 20, 1953	47.01	144.97	69,100
1954	May 17, 1954	26.66	124.62	13,800
1955	Apr. 18, 1955	26.80	124.76	13,900
1956	Apr. 10, 1956	26.12	124.08	13,200
1957	May 11, 12, 1957	45.05	143.01	59,400
1958	May 16, 1958	43.27	141.23	41,600

TABLE 5. CHEMICAL ANALYSES OF SABINE RIVER NEAR TATUM, TEXAS, WATER YEAR 1954

LOCATION—At gaging station at bridge on State Highway 43, 5 miles upstream from Potters Creek, 5.2 miles northeast of Tatum, Rusk County, 7 miles downstream from Cherokee Bayou, and at mile 339.
DRAINAGE AREA—3,586 square miles.
RECORDS AVAILABLE—Chemical analyses: February 1952 to September 1954.
Water temperatures: February 1952 to September 1954.
EXTREMES, 1953-54—Dissolved solids: Maximum, 682 ppm Dec. 7-10, 13; minimum, 178 ppm Jan. 22-31.
Hardness: Maximum, 106 ppm Sept. 1-10; minimum, 39 ppm May 12-23.
Specific conductance: Maximum daily, 1,200 micromhos Dec. 7-10; minimum daily, 187 micromhos May 15.
Water temperatures: Maximum observed, 95°F July 7, 13; minimum observed, 45°F on several days during December and January.
EXTREMES, 1952-54—Dissolved solids: Maximum, 682 ppm Dec. 7-10, 13, 1953; minimum, 82 ppm May 10-20, 1953.
Hardness: Maximum, 106 ppm Sept. 1-10, 1954; minimum, 29 ppm Sept. 9-10, 12-18, 1953.
Specific conductance: Maximum daily, 1,200 micromhos Dec. 7-10, 1953; minimum daily, 123 micromhos May 10-11, 1953.
Water temperatures: Maximum observed, 95°F July 7, 13, 1954; minimum observed, 45°F on several days during December 1953 and January 1954.
REMARKS—Values reported for dissolved solids are residues on evaporation. Records of specific conductance of daily samples available in district office at Austin, Texas. Records of discharge for water year October 1953 to September 1954 given in Water-Supply Paper 1242.

Chemical analyses, in parts per million, for water year October 1953 to September 1954

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (Residue at 180°C)			Hardness as $CaCO_3$		Percent Sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
											Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-11, 1953	91.4	15	16	6.0	126		38	16	205	1.5	432	0.59	107	64	34	81	6.8	786	7.2
Oct. 12-23, 27-28	80.6	14	15	5.8	105		47	18	165	.8	376	.50	79.9	62	23	79	5.8	664	7.5
Oct. 24-26, 29-31	126	13	18	6.9	144		47	19	232	1.0	470	.64	160	74	35	81	7.3	869	7.3
Nov. 1-7, 20-23	360	11	17	6.0	144		40	19	232	1.2	480	.65	467	67	34	82	7.7	802	7.0
Nov. 8-11, 14-19	289	14	12	4.6	66		32	17	104	1.0	255	.35	199	49	23	74	4.1	446	7.0
Nov. 12-13, 24-30	520	14	14	5.0	78		29	18	129	1.2	302	.41	424	56	32	75	4.6	524	6.8
Dec. 1-5, 18-19, 29-31	1,401	18	14	4.6	78		25	25	125	1.2	318	.43	1,200	54	33	76	4.6	521	6.8
Dec. 6, 11-12, 14-17, 20-28	1,944	17	14	4.1	42		30	22	67	1.0	228	.31	1,200	52	27	64	2.5	323	7.0
Dec. 7-10, 13	1,956	18	20	4.9	207		18	38	330	.8	682	.93	3,600	70	56	87	11	1,200	6.6
Jan. 1-15, 1954	815	28	16	5.2	77		18	34	126	1.2	301	.41	662	61	47	73	4.3	529	6.8
Jan. 16-21	3,247	18	13	4.5	52		12	30	86	1.2	236	.32	2,070	51	41	69	3.2	381	6.9
Jan. 22-31	4,639	17	11	3.2	28		26	21	40	1.5	178	.24	2,230	41	19	60	1.9	225	7.2
Feb. 1-9	3,608	23	19	5.3	43		46	34	62	2.0	230	.31	2,240	69	32	57	2.2	358	7.5
Feb. 10-25	1,239	24	17	6.4	64		28	39	102	1.2	287	.39	960	69	46	67	3.4	479	7.4

Feb. 26-28, Mar. 1-5	2,046	18	14	4.9	45	28	33	67	2.2	231	.31	1,280	55	32	64	2.7	346	7.2
Mar. 6-15	652	28	16	6.4	64	26	35	104	1.5	281	.38	495	66	45	68	3.4	476	7.2
Mar. 16-23	613	23	16	6.8	72	25	37	117	1.8	310	.42	513	68	47	70	3.8	512	7.2
Mar. 24-31	694	23	17	7.4	71	23	39	118	1.0	314	.43	588	73	54	68	3.6	529	7.2
Apr. 1-15	588	18	20	8.2	95	29	46	154	1.0	380	.52	603	84	60	71	4.5	665	7.2
Apr. 16-19, 26-30	1,141	19	21	5.9	55	51	35	83	2.0	263	.36	810	77	35	61	2.7	440	7.3
Apr. 20-25	2,253	17	20	4.5	32	64	26	40	3.0	197	.27	1,200	68	16	51	1.7	296	7.5
May 1-11	1,095	20	14	4.1	56	33	24	84	2.5	236	.32	698	52	25	70	3.3	399	7.4
May 12-23	4,520	15	11	2.8	37	25	20	54	3.5	192	.26	2,340	39	18	68	2.6	274	7.3
May 24-31	1,926	20	18	3.7	46	51	20	67	3.0	210	.29	1,090	60	18	62	2.6	346	7.8
June 1-10	1,108	22	15	5.1	54	38	22	85	1.5	226	.31	676	58	27	67	3.0	390	7.1
June 11-22	430	24	25	5.3	52	86	20	74	1.5	244	.33	283	84	14	57	2.5	432	7.7
June 23-30	113	23	26	6.7	88	84	18	139	.5	348	.47	106	92	24	67	4.0	641	7.6
July 1-10	53.5	24	25	7.3	100	91	11	158	1.8	398	.54	57.5	92	18	70	4.5	694	7.7
July 11-20	30.0	22	24	8.0	111	96	8.4	174	2.0	420	.57	34.0	93	14	72	5.0	747	7.7
July 21-31	27.5	21	25	8.1	123	99	6.4	195	1.5	460	.63	34.1	96	15	74	5.5	825	7.5
Aug. 1-10	22.6	19	23	7.2	116	93	13	176	1.5	416	.57	25.4	87	11	74	5.4	761	7.8
Aug. 11-20	14.1	15	23	7.2	117	92	16	176	.8	416	.57	15.8	87	12	74	5.4	764	7.9
Aug. 21-31	13.9	14	24	8.2	138	95	15	212	1.0	469	.64	17.6	94	16	76	6.2	864	7.6
Sept. 1-10	10.8	18	28	8.7	163	98	12	260	2.0	553	.75	16.1	106	26	77	6.9	1,060	8.1
Sept. 11-20	11.1	16	27	8.6	158	100	13	248	1.8	526	.72	15.8	103	21	77	6.8	1,020	8.1
Sept. 21-30	10.3	14	25	8.4	153	108	9.7	235	.8	509	.69	14.2	97	8	77	6.8	984	8.1
Weighted average	1,004	19	15	4.6	55	32	27	85	1.9	252	.34	683	56	30	68	3.2	398	.....

TABLE 6. CHEMICAL ANALYSES OF SABINE RIVER NEAR TATUM, TEXAS, WATER YEAR 1955

LOCATION—At gaging station at bridge on State Highway 43, 5 miles upstream from Potter's Creek, 5.2 miles northeast of Tatum, Rusk County, 7 miles downstream from Cherokee Bayou, and at mile 339.
DRAINAGE AREA—3,586 square miles.
RECORDS AVAILABLE—Chemical analyses: February 1952 to September 1955.
Water temperatures: February 1952 to September 1955.
EXTREMES, 1954-55—Dissolved solids: Maximum, 823 ppm Oct. 16-25; minimum, 119 ppm Oct. 31, Nov. 1-8, 12-15.
Hardness: Maximum, 94 ppm Oct. 16-25; minimum, 32 ppm Sept. 3-4, 7-13.
Specific conductance: Maximum daily, 1,850 micromhos Oct. 25; minimum daily, 154 micromhos Nov. 4.
Water temperatures: Maximum observed, 90°F July 7-11; minimum observed, 45°F Mar. 26-28.
EXTREMES, 1952-55—Dissolved solids: Maximum, 823 ppm Oct. 16-25, 1954; minimum, 82 ppm May 10-20, 1953.
Hardness: Maximum 106 ppm Sept. 1-10, 1954; minimum, 29 ppm Sept. 9-10, 12-18, 1953.
Specific conductance: Maximum daily, 1,850 micromhos Oct 25, 1954; minimum daily, 123 micromhos May 10-11, 1953.
Water temperatures: Maximum observed, 95°F July 7, 13, 1954; minimum observed, 45°F on several days during winter months.
REMARKS—Values reported for dissolved solids are residues on evaporation unless otherwise noted. Records of specific conductance of daily samples available in district office at Austin, Texas. Records of discharge for water year October 1954 to September 1955 given in Water-Supply Paper 1392.

Chemical analyses, in parts per million, for water year October 1954 to September 1955

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (Residue at 180°C)			Hardness as $CaCO_3$		Percent Sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
											Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-15, 1954	27.3	12	22	7.1	174		121	7.9	252	0.8	536[1]	0.73	39.5	84	0	82	8.3	1,020	7.7
Oct. 16-25	80.0	7.8	24	8.4	262		69	20	415	1.0	823	1.12	178	94	38	86	12	1,510	7.8
Oct. 26-30	916	8.8	17	5.7	124		26	30	199	2.8	446	.61	1,100	66	44	80	6.6	787	6.8
Oct. 31, Nov. 1-8, 12-15	3,200	11	13	2.1	25		37	15	33	2.0	119[1]	.16	1,030	40	10	57	1.7	211	7.2
Nov. 9-11, 16-26	2,057	13	14	3.4	54		28	24	84	1.2	231	.31	1,280	50	27	70	3.3	381	7.3
Nov. 27-30	408	16	18	4.8	77		31	29	124	3.0	294	.40	324	65	40	72	4.2	523	7.3
Dec. 1-10	250	20	25	5.2	122		28	38	202	2.0	461	.63	311	83	60	76	5.8	803	6.7
Dec. 11-12, 15-20, 25-31	802	18	18	4.5	81		17	36	133	1.5	326	.44	706	63	49	74	4.5	553	6.4
Dec. 13-14, 21-24	841	16	20	4.9	105		16	37	175	.8	399	.54	906	70	57	77	5.5	686	6.4
Jan. 1-3, 8-11, 1955	527	20	17	7.1	97		18	43	158	1.2	386	.52	549	72	58	75	5.0	658	6.9
Jan. 4-7, 12-20	992	18	15	6.8	84		16	41	136	1.2	342	.47	916	66	58	73	4.5	582	6.8
Jan. 21-31	1,398	17	16	6.2	71		18	44	112	1.2	304	.41	1,150	65	50	70	3.8	509	7.0
Feb. 1-8	2,168	16	13	4.5	53		15	28	87	1.0	236	.32	1,380	50	38	70	3.3	387	6.7
Feb. 9-19	3,193	14	15	4.0	36		31	29	53	2.5	168[1]	.23	1,450	55	30	58	2.1	302	7.0

Feb. 20-28	2,422	16	14	4.7	49	15	32	81	1.0	228	.31	1,490	54	42	66	2.9	375	6.7
Mar. 1-9	1,308	17	17	5.5	56	30	37	87	2.0	255	.35	901	65	40	65	3.0	426	7.3
Mar. 10-19	637	20	18	6.9	87	22	42	141	1.8	352	.48	605	73	55	72	4.4	608	7.1
Mar. 20-31	4,723	10	9.5	3.0	35	15	19	55	1.8	178	.24	2,270	36	24	68	2.5	263	7.0
Apr. 1-10	3,339	15	15	4.4	46	35	31	67	1.0	229	.31	2,060	56	27	64	2.7	343	7.3
Apr. 11-20	4,845	15	12	3.9	35	23	26	52	1.0	187	.25	2,450	45	26	63	2.2	272	7.0
Apr. 21-29	4,053	16	14	4.1	31	43	21	44	1.5	187	.25	2,050	53	18	56	1.9	271	7.2
Apr. 30, May 1-10	626	22	18	6.5	68	36	31	111	2.0	302	.41	510	71	42	68	3.5	515	7.4
May 11-22	464	20	17	6.7	90	35	28	147	1.5	352	.48	441	71	42	73	4.6	607	7.1
May 23-27	2,618	12	9.1	3.0	31	19	17	48	1.5	157	.21	1,110	35	19	66	2.3	235	7.0
May 28-31	1,298	16	16	5.3	74	31	25	119	2.0	307	.42	1,080	61	36	72	4.1	511	7.1
June 1-7	558	22	17	5.2	49	47	24	75	2.8	238	.32	359	64	26	63	2.7	390	7.5
June 8-16	282	22	19	6.6	98	46	28	157	1.5	374	.51	285	75	38	74	4.9	650	7.5
June 17-23	258	19	17	5.2	72	48	20	112	1.8	290	.39	202	64	25	71	3.9	503	7.4
June 24-30	188	17	21	7.1	134	51	19	220	1.0	475	.65	241	81	39	78	6.5	858	7.3
July 1-10	93.2	18	18	5.6	98	59	16	153	1.0	340	.46	85.6	68	20	76	5.2	643	7.9
July 11-18	229	15	16	5.3	118	42	15	189	1.2	389	.53	241	62	28	80	6.5	730	7.1
July 19-31	377	15	13	4.5	74	32	18	117	1.2	274	.37	279	50	24	76	4.6	487	7.1
Aug. 1-13	452	13	14	3.4	75	28	16	121	1.8	274	.37	334	48	25	77	4.7	499	7.1
Aug. 14-16, 23-26	235	14	20	7.0	181	38	21	298	1.8	580	.79	368	80	49	83	8.8	1,110	7.5
Aug. 17-22, 27-31	214	16	13	4.9	73	39	19	112	1.2	264	.36	153	53	21	75	4.3	493	7.3
Sept. 1-2, 5-6	1,028	13	14	3.8	192	27	20	145	2.0	332	.45	922	50	28	80	5.6	575	7.0
Sept. 3-4, 7-13	670	14	8.9	2.4	37	27	13	53	2.5	144[1]	.20	260	32	10	72	2.8	254	7.3
Sept. 14-16, 26-30	601	12	11	3.4	58	28	14	90	2.0	229	.31	372	41	18	75	3.9	380	7.1
Sept. 17-25	171	13	15	4.3	89	38	16	141	1.5	322	.44	149	55	24	78	5.2	571	7.4
Weighted average	1,291	14	14	4.1	51	29	26	79	1.6	226	.31	788	52	28	68	3.1	370	.....

[1] Sum of determined constituents.

TABLE 7. CHEMICAL ANALYSES OF SABINE RIVER NEAR RULIFF, TEXAS, WATER YEAR 1954

LOCATION—At gaging station at bridge on State Highway 235, 2.4 miles north of Ruliff, Newton County, 4.2 miles upstream from Kansas City-Southern Railway bridge, 4.5 miles downstream from Cypress Creek and at mile 40.
DRAINAGE AREA—9,440 square miles.
RECORDS AVAILABLE—Chemical analyses: October 1945 to September 1946, October 1947 to September 1954.
Water temperatures: October 1947 to September 1954.
EXTREMES, 1953-54—Dissolved solids: Maximum, 326 ppm Dec. 16-22; minimum, 57 ppm May 4-10, 15.
Hardness: Maximum, 52 ppm Dec. 16-22; minimum, 16 ppm May 4-10, 15.
Specific conductance: Maximum daily, 588 micromhos Dec. 21; minimum daily, 61.6 micromhos May 6.
Water temperatures: Maximum observed, 89°F June 9; minimum observed, 50°F Jan. 20-23.
EXTREMES, 1945-46, 1947-54—Dissolved solids: Maximum, 411 ppm Dec. 26-27, 1948; minimum, 35 ppm June 5-11, 1950.
Hardness: Maximum, 64 ppm Aug. 1, 11, 16-19, 21-23, 1948; minimum, 8 ppm May 20-24, 1953.
Specific conductance: Maximum daily, 774 micromhos Dec. 26, 1948, minimum daily, 32.9 micromhos May 22, 1953.
Water temperatures (1947-54): Maximum observed, 95°F Aug. 12, 1953; minimum observed, 34°F Jan. 24, 1948.
REMARKS—Values reported for dissolved solids are residues on evaporation unless otherwise noted. Records of specific conductance of daily samples available in district office at Austin, Texas. Records of discharge for water year October 1953 to September 1954 given in Water-Supply Paper 1342.

Chemical analyses, in parts per million, for water year October 1953 to September 1954

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (Residue at 180°C)			Hardness as $CaCO_3$		Percent Sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
											Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-2, 10-20, 1953	9,784	23	7.3	3.0	29		36	6.7	40	1.0	134	0.18	3,540	30	1	68	2.3	211	7.2
Oct. 3-9	1,141	21	9.1	3.3	54		32	8.6	83	.5	196	.27	604	36	10	76	3.9	346	7.1
Oct. 21-31	9,192	22	6.5	2.5	24		34	5.7	31	1.2	114	.16	2,830	26	0	66	2.0	178	7.0
Nov. 1-10	1,001	20	6.4	2.4	28		31	6.1	38	1.2	139	.19	376	26	0	70	2.4	193	6.9
Nov. 11-20	1,067	21	6.9	2.8	37		33	6.6	53	.5	147	.20	423	28	2	74	3.0	247	7.1
Nov. 21-30	1,419	20	6.9	2.8	41		32	8.4	59	.2	156	.21	598	28	2	76	3.3	266	6.9
Dec. 1-15	4,799	11	7.0	2.5	29		18	11	46	1.5	146	.20	1,890	28	14	70	2.4	219	6.9
Dec. 16-22	4,977	14	13	4.9	86		18	25	141	1.0	326	.44	4,380	52	38	78	5.2	543	6.6
Dec. 23-31	5,233	13	8.2	2.8	21		22	14	31	1.5	102[1]	.14	1,440	32	14	58	1.6	182	6.6
Jan. 1-11, 15-17, 1954	5,112	14	7.0	2.5	20		18	13	31	.8	97[1]	.13	1,340	28	14	61	1.7	186	7.2
Jan. 12-14, 18-23	6,182	15	7.7	3.8	37		16	21	56	1.0	150[1]	.20	2,500	34	22	70	2.7	278	6.8
Jan. 24-31	7,670	13	8.0	3.7	30		14	22	46	.8	130[1]	.18	2,690	35	24	65	2.2	243	7.1
Feb. 1-8	7,972	12	9.7	3.7	26		26	20	36	1.0	121[1]	.16	2,600	39	18	59	1.8	218	7.1
Feb. 9-18	5,990	15	13	4.1	30		31	26	44	1.2	148[1]	.20	2,390	50	24	57	1.9	269	7.2
Feb. 19-28	3,750	16	12	4.5	35		32	25	51	.8	160[1]	.22	1,620	48	22	61	2.2	288	7.3

Mar. 1-9	4,444	16	11	4.8	39	23	26	61	.8	201	.27	2,410	47	28	65	2.5	305	7.2
Mar. 10-20	2,754	19	11	4.8	27	30	21	42	1.0	170	.23	1,260	47	22	56	1.7	245	7.2
Mar. 21-31	2,433	20	11	4.2	36	32	20	54	1.5	177	.24	1,160	45	19	64	2.4	286	7.2
Apr. 1-10	2,229	18	11	5.0	38	34	21	57	.5	182	.25	1,100	48	20	63	2.4	305	7.3
Apr. 11-16, 26-30	4,071	14	9.8	4.3	39	27	24	56	.5	176	.24	1,930	42	20	67	2.6	285	7.0
Apr. 17-25	1,281	9.0	5.0	1.8	20	17	11	26	.5	81[1]	.11	280	20	6	68	1.9	145	6.6
May 1-3, 11-14, 16-20	12,550	11	5.4	2.2	17	12	10	26	3.5	81[1]	.11	2,740	22	12	62	1.6	133	6.4
May 4-10, 15	20,380	9.6	3.8	1.7	11	12	6.4	16	2.5	57[1]	.08	3,140	16	6	60	1.2	83.6	6.4
May 21-31	15,640	12	6.2	2.2	17	14	12	26	1.8	84[1]	.11	3,550	24	13	60	1.5	138	6.5
June 1-10	6,428	20	10	3.0	25	37	14	31	2.8	136	.18	2,360	38	7	59	1.7	201	7.4
June 11-20	2,830	24	11	2.1	40	39	15	52	1.5	182	.25	1,390	36	4	70	2.9	273	7.3
June 21-30	1,759	24	11	4.0	34	42	14	49	1.2	161	.22	765	44	10	63	2.3	272	7.2
July 1-10	1,039	22	11	4.5	32	50	12	44	1.2	159	.22	446	46	5	61	2.1	269	7.6
July 11-20	749	22	11	4.3	30	53	9.2	39	2.5	153	.21	309	45	2	59	1.9	243	7.4
July 21-31	601	21	10	4.2	31	51	8.4	40	2.5	149	.20	242	42	0	61	2.1	243	7.2
Aug. 1-10	693	20	9.0	3.2	29	44	7.2	38	.8	129[1]	.18	241	36	0	64	2.1	223	7.0
Aug. 11-20	438	20	9.4	3.4	30	48	7.5	38	1.0	133[1]	.18	157	38	0	63	2.1	223	6.9
Aug. 21-31	421	20	9.1	3.2	30	47	6.7	38	1.0	134	.18	152	36	0	64	2.2	225	6.9
Sept. 1-10	371	21	8.8	3.3	32	48	6.1	42	1.0	141	.19	141	36	0	67	2.4	231	7.4
Sept. 11-20	344	22	8.8	3.3	34	48	6.1	44	1.0	147	.20	137	36	0	67	2.5	242	7.5
Sept. 21-30	329	20	7.1	2.8	33	49	5.4	39	1.0	138	.19	123	29	0	71	2.7	225	7.7
Weighted average	4,097	14	8.3	2.9	26	22	14	38	1.6	121	.16	1,340	32	14	63	2.0	202	.....

[1]Sum of determined constituents.

TABLE 8. CHEMICAL ANALYSES OF SABINE RIVER NEAR RULIFF, TEXAS, WATER YEAR 1955

LOCATION—At gaging station at bridge on State Highway 235, 2.4 miles north of Ruliff, Newton County, 4.2 miles upstream from Kansas City-Southern Railway bridge, 4.5 miles downstream from Cypress Creek and at mile 40.
DRAINAGE AREA—9,440 square miles.
RECORDS AVAILABLE—Chemical analyses: October 1945 to September 1946, October 1947 to September 1955.
Water temperatures: October 1947 to September 1955.
EXTREMES, 1954-55—Dissolved solids: Maximum, 318 ppm Dec. 21-22; minimum, 37 ppm Aug. 5-13.
Hardness: Maximum, 65 ppm Dec. 21-22; minimum, 10 ppm May 22.
Specific conductance: Maximum daily, 612 micromhos Dec. 22; minimum daily, 50.4 micromhos Aug. 9.
Water temperatures: Maximum observed, 88°F July 11-12, 24; minimum observed, 42°F Jan. 31, Feb. 13.
EXTREMES, 1945-46, 1947-55—Dissolved solids: Maximum, 411 ppm Dec. 26-27, 1948; minimum, 35 ppm June 5-11, 1950.
Hardness: Maximum, 65 ppm Dec. 21-22, 1954; minimum, 8 ppm May 20-24, 1953.
Specific conductance: Maximum daily, 774 micromhos Dec. 26, 1948; minimum daily, 32.9 micromhos May 22, 1953.
Water temperatures (1947-54): Maximum observed, 95°F Aug. 12, 1953; minimum observed, 34°F Jan. 28, 1948.
REMARKS—Values reported for dissolved solids are residues on evaporation unless otherwise noted. Records of specific conductance of daily samples available in district office at Austin, Texas. Records of discharge for water year October 1954 to September 1955 given in Water-Supply Paper 1392.

Chemical analyses, in parts per million, for water year October 1954 to September 1955

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (Residue at 180°C)			Hardness as $CaCO_3$		Percent Sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
											Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Oct. 1-10, 1954	333	21	7.7	2.8	33		47	6.2	40	1.0	142	0.19	128	30	0	70	2.6	223	6.9
Oct. 11-20	391	21	7.2	2.6	32		43	5.3	40	1.0	142	.19	150	28	0	71	2.6	222	7.2
Oct. 21-31	446	19	7.3	2.4	35		40	6.5	45	1.0	148	.20	178	28	0	73	2.9	231	7.1
Nov. 1-6	690	18	7.2	3.6	40		40	9.8	55	.8	158	.21	294	33	0	73	3.1	270	7.3
Nov. 7-12	2,910	13	11	4.3	84		28	20	129	2.0	294	.40	2,310	45	22	80	5.4	520	7.1
Nov. 13-20	4,220	11	10	3.5	22		32	17	31	1.2	112[1]	.15	1,276	40	14	55	1.5	197	7.0
Nov. 21-30	2,931	12	11	3.6	31		32	19	45	1.2	139[1]	.19	1,100	42	16	62	2.1	249	6.9
Dec. 1-10	1,452	16	14	2.6	43		28	22	66	1.2	206	.28	808	46	23	67	2.8	318	7.3
Dec. 11-20	1,278	17	13	2.6	43		27	19	66	1.5	194	.26	669	43	21	68	2.8	311	7.4
Dec. 21-22	2,940	19	19	4.0	80		32	30	128	1.0	318	.43	2,520	65	39	73	4.3	534	7.4
Dec 23-31	2,070	14	10	2.6	43		18	18	68	1.5	191	.26	1,070	36	22	72	3.1	305	6.5
Jan. 1-7, 1955	1,570	17	7.4	3.8	35		20	19	52	1.0	159	.22	674	34	18	69	2.6	261	7.0
Jan. 8-11	2,040	16	8.4	4.1	52		17	22	80	1.8	209	.28	1,150	38	24	75	3.7	351	7.0
Jan. 12-20, 22, 29-31	3,830	14	6.4	2.9	33		14	16	50	1.0	148	.20	1,530	28	16	72	2.7	232	6.6
Jan. 21, 23-28	6,370	14	8.8	4.1	46		12	23	74	1.8	207	.28	3,560	39	29	72	3.2	334	6.5

Feb. 1-6, 16-23, 27-28	8,300	11	6.6	3.1	30	14	21	42	1.5	148	.20	3,320	29	18	69	2.4	218	6.9
Feb. 7-11, 24-26	17,420	7.4	4.0	1.5	14	11	10	19	1.2	62[1]	.08	2,920	16	7	66	1.6	109	6.5
Feb. 12-15	16,420	9.0	5.0	1.8	18	10	14	26	1.0	80[1]	.11	3,550	20	12	67	1.8	144	6.8
Mar. 1-8	8,260	14	9.2	2.9	24	15	21	36	1.8	116[1]	.16	2,590	35	22	60	1.8	201	6.7
Mar. 9-17	3,710	17	11	4.0	35	24	27	51	1.0	158[1]	.21	1,580	44	24	63	2.3	271	7.0
Mar. 18-26	3,330	19	13	3.9	37	30	24	56	1.5	169[1]	.23	1,520	49	24	62	2.3	292	7.1
Mar. 27-31, Apr. 1-12	10,520	10	8.8	2.2	22	18	16	33	1.8	103[1]	.14	2,930	31	16	61	1.7	188	6.7
Apr. 13-22	23,880	8.8	4.6	1.6	12	13	9.3	16	1.5	60[1]	.08	3,870	18	7	59	1.2	107	6.8
Apr. 23-30	13,610	13	7.8	2.6	23	24	17	29	2.2	107[1]	.15	3,930	30	10	62	1.8	178	6.5
May 1-10	5,980	15	12	3.7	26	36	18	36	1.2	156	.21	2,520	44	14	56	1.7	231	7.0
May 11-20, 23-25	5,560	16	11	3.5	31	34	17	44	1.5	154	.21	2,310	42	14	61	2.1	247	6.7
May 22	9,600	.....	.....	.....	.....	7	.....	10	.....	.....	.....	.....	10	4	.....	.....	59.1	6.7
May 21, 26-31	9,630	9.0	5.6	1.9	20	17	9.6	29	1.0	84[1]	.11	2,180	22	8	67	1.9	151	6.6
June 1-6	9,080	12	6.6	2.3	16	21	12	22	1.5	82[1]	.11	2,010	26	9	58	1.4	145	6.8
June 7-14	3,430	17	9.2	3.2	24	28	13	36	1.2	139	.19	1,290	36	13	59	1.8	206	6.9
June 15-30	1,740	22	11	3.9	34	42	14	48	1.0	167	.23	785	44	10	63	2.2	268	7.3
July 1-10	1,450	18	10	3.7	35	40	13	49	1.0	162	.22	634	40	7	66	2.4	267	7.0
July 11-17	1,500	17	10	3.5	46	37	9.6	69	1.5	184	.25	745	40	10	71	3.1	316	7.4
July 18-23, 30-31	3,090	9.0	4.2	1.8	17	20	5.9	22	.8	71[1]	.10	592	18	2	67	1.7	127	6.7
July 24-29	3,390	11	7.0	2.6	35	26	8.9	51	.8	129[1]	.18	1,180	28	6	73	2.9	238	6.7
Aug. 1-3	3,010	12	7.8	2.5	28	31	5.6	42	.8	114[1]	.16	926	30	4	67	2.2	206	7.5
Aug. 4, 14-20, 30-31	8,300	11	4.8	1.5	12	19	5.2	16	1.0	60[1]	.08	1,340	18	2	60	1.2	101	6.8
Aug. 5-13	22,280	6.2	3.2	.7	5.7 | 2.0	10	3.2	10	1.0	37[1]	.05	2,230	11	3	48	.8	57.2	6.5
Aug. 21-29	2,610	16	7.0	2.6	22	30	7.3	30	1.5	112	.15	789	28	4	63	1.8	168	6.9
Sept. 1-9	5,220	12	4.2	1.3	14	20	3.9	18	1.2	65[1]	.09	916	16	0	66	1.6	106	6.4
Sept. 10-11, 13-14, 21-22	2,180	18	8.2	2.6	34	35	7.7	48	.8	136[1]	.18	800	31	2	70	2.6	240	7.3
Sept. 12, 15-20	2,120	15	11	3.3	52	30	12	82	1.5	208	.28	1,190	41	16	73	3.5	356	6.6
Sept. 23-30	2,350	14	5.6	1.4	20	22	5.5	28	1.5	87[1]	.12	552	20	2	69	2.0	141	6.7
Weighted average	5,574	11	6.9	2.3	22	19	13	32	1.4	104	.14	1,570	26	11	64	1.9	174	.....

[1]Sum of determined constituents.

TABLE 9. CHEMICAL ANALYSES OF SURFACE WATER OF SELECTED SITES IN OR NEAR SABINE PARISH, LA.

Chemical analyses in parts per million

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (calculated except where indicated otherwise)			Hardness as $CaCO_3$		Percent Sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
													Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
Bayou San Miguel near Zwolle, La.																					
Aug. 20, 1952....	0.0	7.0	0.05	8.8	6.2	16	...	71	3.2	14	0.2	1.8	110[1]	0.15	0.0	47	0	42	1.0	178	6.7
Oct. 19, 1954....	.....	9.0	.05	9.8	7.0	16		84	2.0	12	.....	1.0	110[1]	.15	.....	53	0	40	1.0	184	6.9
Nov. 16.....	.....	3.4	.03	9.4	5.9	18		78	3.1	14	.....	.8	104[1]	.14	.....	48	0	46	1.2	180	6.8
Dec. 17.....	.....	3.9	.00	11	5.9	18		82	2.7	14	.....	.8	104[1]	.14	.....	51	0	44	1.1	185	6.9
Feb. 9, 1955.....	42	7.6	.23	2.7	1.9	6.3	2.7	8	13	7.2	.....	1.0	47	.06	5.3	14	8	43	.7	79	5.8
Apr. 1.....	4.3	13	.36	5.5	3.0	11		18	17	12	.....	.5	71	.10	.8	26	11	48	.9	123	6.5
Apr. 29.....	2.9	15	2.0	8.8	4.4	15		40	15	17	.....	.8	98	.13	.7	40	7	45	1.0	162	6.7
May 24.....	258	6.4	.39	2.2	1.6	5.0	...	11	6.2	5.0	.....	.5	32	.04	22	12	3	47	.6	56	5.9
June 21.....	1.6	6.4	.65	5.6	2.7	9.4	2.9	32	6.6	11	.....	1.0	62	.08	.3	25	0	42	.8	110	6.4
July 27.....	2.1	7.4	.68	4.8	2.4	12		33	6.7	9.0	.....	1.2	60	.08	.3	22	0	54	1.1	109	6.8
Sept. 14.....	.2	7.2	.42	7.3	4.3	12		54	2.7	10	.....	.5	71	.10	.0	36	0	42	.8	133	6.7
June 20, 1956....	.0	7.0	.06	11	6.1	21		78	3.8	21	.....	1.2	109	.15	.0	53	0	46	1.2	205	7.4
Jan. 31, 1957....	268	6.4	.50	1.8	1.5	4.0	2.9	6	7.6	5.5	.7	.8	35	.05	25	11	6	38	.5	49	5.4
Mar. 1.....	24	15	.81	5.5	3.0	15		14	24	16	.....	.5	87	.12	5.6	26	15	56	1.3	140	6.3
Bayou San Patricio near Noble, La.																					
Aug. 20, 1952....	14	8.4	.01	34	9.6	485	3.2	23	4.4	835	.2	2.2	1,390	1.89	53	124	106	89	19	2,750	6.3
Aug. 14, 1955....	6.8	19	1.4	7.4	2.6	10		34	7.1	11	.....	.5	76	.10	1.4	29	1	43	.8	126	6.6
Sept. 14.....	25	5.2	.53	2.8	1.2	12		16	4.0	14	.....	.8	49	.07	3.3	12	0	68	1.5	86	6.4
Oct. 18.....	6.2	30	.85	3.2	.7	5.3	2.7	20	4.2	4.0	.....	.2	61	.08	1.0	11	0	44	.7	55	6.5
Nov. 30.....	.6	15	.06	13	6.1	..		59	2.3	84	.....	.2	202	.29	.3	57	9	66	3.0	380	7.3

Jan. 5, 1956	.9	14	.09	11	5.0		95	40	7.0	152	.....	.2	304	.43	.7	48	15	81	6.0	577	6.6
Feb. 29	19	15	.72	9.6	4.6		53	26	18	84	.....	.7	199	.27	10	43	22	73	3.5	360	6.5
Mar. 27	28	14	.65	10	6.0		46	30	24	70	.....	.9	186	.25	14	50	25	67	2.8	338	6.5
Apr. 25	12	16	.78	11	5.3		85	30	16	137	.....	.7	287	.39	9.3	49	25	79	5.3	542	6.5
May 23	5.2	15	.92	9.1	3.7		39	38	11	56	.....	1.3	155	.21	2.2	38	7	69	2.7	273	6.6
Apr. 19, 1957	66	15	.87	6.0	3.2		21	19	18	28	.....	.8	102	.14	18	28	13	62	1.8	172	6.5
May 15	62	16	.89	7.3	3.5		30	28	9.4	45	.....	1.5	128	.17	21	33	10	67	2.3	223	6.2
June 14	29	16	2.1	7.3	2.8		31	24	10	46	.....	2.2	129	.18	10	30	10	69	2.5	229	5.9
July 8	5.8	18	3.0	9.5	4.1		38	40	11	55	.....	2.2	161	.22	2.5	41	8	67	2.6	280	6.2
Sept. 3	.5	5.4	.20	13	6.4		29	77	.4	41	.....	1.0	134	.18	.2	59	0	52	1.6	295	7.2
Bayou Toro near Toro, La.																					
Nov. 6, 1959	9.1	23	.24	3.7	1.2	1.2	5.3	16	5.0	5.2	.1	.4	53	.07	1.3	14	1	43	.6	64	6.3
Dec. 10	9.0	25	.15	3.8	.6	7.4	2.3	17	8.6	6.0	.2	.1	62	.08	1.5	12	0	52	.9	67	6.2
Feb. 4, 1960	662	13	.37	4.5	.9	6.7	2.2	14	8.3	.01	.1	1.0	54	.07	96	15	10	45	.7	82	5.5
Mar. 1	140	17	.37	4.4	1.7	6.4	1.4	8	15	8.0	.2	.5	59	.08	22	18	12	41	.7	74	6.6
Apr. 6	47	19	.35	5.1	1.8	8.7	1.8	19	12	9.2	.1	.3	67	.09	8.4	20	4	46	.8	82	6.6
May 3	23	21	.40	5.9	1.3	8.0	1.7	19	10	9.4	.2	.4	67	.09	4.2	20	4	44	.8	82	5.7
May 31	7.3	22	.83	5.4	1.1	8.5	1.9	25	7.6	7.2	.1	.0	67	.10	1.3	18	0	47	.9	84	6.6
July 6	12	20	.40	7.0	1.6	5.1	2.4	19	7.8	9.4	.1	.5	64[1]	.09	2.1	24	8	29	.4	81	5.7
Aug. 3	7.1	18	.47	7.6	1.2	4.8	1.2	18	7.8	9.0	.1	.6	60	.08	1.2	24	9	29	.4	87	6.1
Bayou La Nana near Many, La.																					
Oct. 29, 1959	.4	12	.77	10	6.1	21	3.4	63	25	16	.4	1.1	127	.17	.14	50	0	46	1.3	183	6.6
Nov. 11	1.1	14	.16	13	5.7	24	3.4	84	16	18	.3	.6	136	.18	.40	56	0	46	1.4	219	6.7
Dec. 9	2.2	16	.31	16	6.6	31	4.3	102	14	30	.3	.3	169	.23	1.0	67	0	48	1.7	286	7.2
Feb. 3, 1960	25	13	.45	13	5.7	33	2.5	32	46	40	.2	.5	170	.23	11	56	0	55	1.9	293	6.6
Mar 1	112	14	.42	8.4	3.7	18	1.7	18	32	20	.1	.5	108	.15	33	36	21	51	1.3	175	6.0
Apr. 6	19	12	.22	14	8.6	39	1.8	58	48	44	.3	.2	204[1]	.28	11	70	22	54	2.0	340	7.1
June 2	23	13	.32	20	6.1	48	2.1	95	23	56	.3	.0	245[1]	.33	1.5	75	0	57	2.4	404	6.5
Loring Lake near Zwolle, La.																					
Apr. 11, 1958	.....	2.0	.14	2.4	.7	3.2	1.6	11	1.2	4.2	.6	.3	21	.03	.....	9	0	39	.5	45	6.3

[1]Residue on evaporation at 180°C.

TABLE 10. RECORDS OF SELECTED WELLS

Stratigraphic unit: Qal, Quaternary alluvium; Mc, Catahoula Formation; Ecc, Cockfield Formation; Ecm, Cook Mountain Formation; Ewc, Carrizo Sand; Ecs, Sparta Sand; Ew, Undifferentiated beds of Wilcox Group.

Quality of water: C, Chemical analyses of water in table 11.

Use: A, abandoned; D, domestic; I, Industrial; Ir, irrigation; N, not in use; O, observation; P, public supply; S, stock; T, test hole.

Remarks: L, log of well in table 11 or 12. Pump yield column: m, measured; others are reported. Well locations shown on plate 2.

Well number	Location			Owner	Driller	Year completed	Altitude (feet above sea level)	Depth (ft.)	Casing diameter (in.)	Aquifer		Water level		Pump yield (gpm)	Use	Quality of water (reported)	Remarks
	Sec.	T. (N)	R. (W)							Screened interval (in ft.)	Stratigraphic unit	Feet below land surface	Date				
Sa- 39	5	4	10	D. E. Self		1939	260	47	30		Mc	44	Sept. 1954		D	Soft	Dug well.
Sa- 42	5			H. R. Self	Manning and Granberry	1949	260	191	4	171-191	Mc	10	1949		D, S	Soft	
Sa- 40	8			W. W. Hall	Tom Sables	1953	341	65	8		Mc	53	June 1954		D	Soft	
V-274	20			W. H. Beckham	Wayne Jacobs	1956	480	250	2	232-250	Mc	180	1956		D	Hard; iron	In Vernon Parish.
Sa-237	36	4	12	I. Miller		1948	174	22	32		Qal	21.2	May 1955		D		Dug well.
Sa-227	23	4	13	M. B. McFarland	Owner	1947	134	20	1½	?-20	Qal	14	April 1955		D	Soft; iron	Driven well.
Sa-122	8	5	9	L. McInnis		1927	360	55	30	?-55	Mc	52	Nov. 1954		D		
Sa-123	11			A. J. Hodges			290	?	6	?	Mc?	Flowing	Dec. 1955		A	Fresh	Old oil test.
Sa-241	6	5	10	M. M. Mahaffey	Rex Kuhlman	1953	320	124	2	115-124	Ecc	50	1955		D		
Sa-239	7			A. C. Arthur	Rex Kuhlman	1954	320	70	2	60-70	Ecc	30	1954	5	D, S	Soft; iron	
Sa-228	22			Plainview High School	Wayne Jacobs	1955	410	263	4	239-263	Mc	130	May 1955	20	P	C	Test hole to 405 feet.
Sa-287	28			A. J. Hodges	Osborn Miller	1958	310	208	6⅝, 4	178-208	Mc	64.0	Dec. 1958	48m	P	C	16-Slot screen. Park well.
Sa- 43	31			S. D. Peterson	Carroll	1953	200								T		Dry hole. Test hole to 400 feet.
Sa-333	1	5	11	Roy Slater	Rex Kuhlman	1956	250	150	2	?-150	Ecc				D	Iron	
Sa- 31	2			Florien High School	Houston Drilling Co.	1949	250	500	10	?-500	Ecs	90	Sept. 1954	50	P	C; sour taste	
Sa-321	2			S. D. Keadle	Rex Kuhlman	1959	265	100	2	90-100	Ecc				D	C	Slotted casing.
Sa-338	2	5	11	G. G. Williams	Shell Oil Co.	1948	245	824?	8, 4		Ecc	2.4	Sept. 1959		N	Iron	Measured depth 231 feet. Open-end casing.
Sa-236	5			Antioch Baptist Church	Carroll & Pevoto	1951	330	285	2	265-285	Ecs	120	May 1955		D	Hard	
Sa- 34	12			W. W. Jett	Rex Kuhlman	1954	235	167	4	143-167	Ecc	0	1954		P	Soft	
Sa- 35	13			D. E. Lester	L. P. Blevins	1948	225	196	4	194-196	Ecc				D	Soft; soda taste	
Sa-233	18	5	12	H. Wedgeworth	Wayne Jacobs	1954	140	312	4	300-312	Ew	20	Sept. 1954	8	D, S	C	

Sa-226	28			W. B. Woodle		1945	190	30	36		Qal	24.6	April 1955		N	Soft	Dug well.
Sa-349	13	5	13	Ivy Morris	Osborn Miller	1959	190	94	2	84-94	Ecs	26	Sept. 1959		D	C	12-slot screen
Sa-111	9	6	9	Mrs. W. C. Montgomery			250	23	36		Ecc	17.3	Nov. 1954		D	Soft	Dug well.
Sa-120	32			A. J. Hodges	G. C. McDaniel		430	180	6		Mc	100	Nov. 1954		D	Soft; iron	Peason Fire Tower, well-point screen.
Sa-121	32			W. W. Herrington	Wayne Jacobs	1954	420	100	4	96-100	Mc	45	Nov. 1954		D	Soft	
Sa-107	3	6	10	Edwin Goodman		1954	360	25	36		Ecs	19	Nov. 1954		D	Soft	Dug well.
Sa-301	5			La. Forestry Commission	Rex Kuhlman	1955	460	220	2	160-220	Ecs or Ewc	80	1955		D	Hard	Fisher Fire Tower.
Sa-307	10			Frank Edwards	Osborn Miller	1959	330	77	2	67-77	Ecs	24	1959		D	Hard; iron	16-slot screen.
Sa-308	10			C. N. Hildebrand	Gerald Beasley	1954	345	120	2	?-120	Ecs				D	C	
Sa-343	10			D. T. Weldon	Wayne Jacobs	1957	360	147	2	137-147	Ecs	40	1957		D	Iron	14-slot screen.
Sa-102	14			Henry Knipper		1948	340	30	36		Ecc	27.4	Nov. 1954		D	Soft	Dug well.
Sa-242	17			Texas Eastern Transmission Corp.	Raborn Drilling Co.	1950	290	90	16,6	70-90	Ecs	30	May 1955	40	D	Hard; iron	L
Sa-303	18			J. H. Hildebrand	Osborn Miller	1959	300	110	2	100-110	Ecs	30	Jan. 1959		D	C	14-slot screen.
Sa-304	18			C. A. Rials	Rex Kuhlman	1957	360	81	2	73-81	Ecs	69	1957		D	Soft	
Sa-251	23			O. B. Chandler	Wayne Jacobs	1955	340	110	2	100-110	Ecc			6	D	Soft	L
Sa-118	27			Roy Skinner	Gerald Beasley	1953	320	83	2	?-83	Ecc				D	Soft; iron	
Sa-213	27			Mount Carmel High School	Houston Drilling Co.	1946	330	145	4	139-145	Ecc				P	C	
Sa-310	27	6	10	Mrs. J. M. Alford	G. C. McDaniel	1955	345	586	2	?	Ecc				D	C	
Sa-116	29			Mrs. N. C. Lockwood		1916	280	30	30		Ecc	19.3	Nov. 1954		D	Soft	Dug well.
Sa-114	30			J. J. Rossiter	Rex Kuhlman	1952	250	104	2	?-104	Ecc	28	Dec. 1952		D	Soft	
Sa-309	34			Rufus Corley		1955	300	486	2	?-486	Ecc	26	1955		D	Hard; iron	
Sa-119	35			E. E. Weldon	Rex Kuhlman	1952	270	308	2	248-308	Ecc	50	1952		D	Very hard	
Sa-299	1	6	11	N. L. Cox	Wayne Jacobs	1955	335	285	2	275-285	Ew	40	1955	8	D	Soft; soda taste	14-slot screen.
Sa-295	2			A. B. Crittenden	Paul Atchison	1957	335	550	2	510-550	Ew	130	1957		D	C	
Sa-231	8			C. W. Hippler		1905	300	25	36		Ew	22.0	May 1955		D	Hard	Dug well.
Sa-300	12			Albert Menasco	Paul Atchison	1956	430	357	2	347-357	Ewc?	127	1956		D	Soft	
Sa- 8	23			Louisiana Longleaf Lumber Co.	B. F. Edington	1944-54	340	100	10, 8	80-100	Ecs	30	Sept. 1954	40	P	C	One of 6 similar wells.
Sa- 27	26			Allen Lewing	Gerald Beasley	1954	310	269	4	?-269	Ecm or Ecs				A		Dry hole reported.
Sa- 29	35			C. H. Jordan	Gerald Beasley	1954	279	57	4	25-57	Ecc	13	Sept. 1954		D	Soft; iron	Slotted casing.
Sa-314	4	6	12	E. M. Patrick	Wayne Jacobs	1955	180	210	4	200-210	Ew	28.0	Sept. 1959		D	Soda	14-slot screen.
Sa- 7	13			N. N. Gandy		1928	270	35	36		Ew	10.3	April 1955		D	90 ppm hardness	Dug well.
Sa- 6	15			Robert Speight		1938	260	28	48		Ew	9.5	July 1940		D	10 ppm hardness	Dug well.
Sa-220	16			R. L. Self	Wayne Jacobs	1954	290	265	2	?-265	Ew				D	Hard	
Sa- 32	26			Negreet High School		1924	190	449	10, 4	?-449	Ew	30		25	P, S	C; natural gas	
Sa-225	26			Alton Isgitt	Wayne Jacobs		210	135	4	115-135	Ew	40	1955	12	D	Soft; soda	L, slotted casing.
Sa-232	27			A. W. Curtis	Gerald Beasley	1954	210	308	3	268-283	Ew	40	1954		D	Soft; soda, gas	
Sa-229	2	6	13	M. L. Nabours		1934	190	22	30		Ew	14.8	May 1955		D	Soft	Dug well.
Sa-230	4			Philip Rivers		1947	200	28	36		Ew	17.6	May 1955		D	Soft	Dug well.

TABLE 10. RECORDS OF SELECTED WELLS—Continued

Well number	Location Sec.	Location T. (N)	Location R. (W)	Owner	Driller	Year completed	Altitude (feet above sea level)	Depth (ft.)	Casing diameter (in.)	Aquifer Screened interval (in ft.)	Aquifer Stratigraphic unit	Water level Feet below land surface	Water level Date	Pump yield (gpm)	Use	Quality of water (reported)	Remarks
Sa-256	28			La. Dept. Highways		1955	146	25	1½	22-25	Qal	11.3	Aug. 1955		T, O		L, test hole to 37 feet.
Sa-254	29			La. Dept. Highways		1955	142	23	1½	20-23	Qal	10.8	Aug. 1955		T, O		L, test hole to 42 feet.
Sa-255	29			La. Dept. Highways		1955	145	32	1½	29-32	Qal	13.2	Aug. 1955		T, O		L, test hole to 47 feet.
Sa-219	30			E. M. Honeycutt		1954	140	18	2	15-18	Qal	11.5	Mar. 1955		D	Soft	Driven well.
Sa-252	30	6	13	La. Dept. Highways		1955	140	36	1½	33-36	Qal	12.2	Aug. 1955		T, O		L, test hole to 48 feet.
Sa-253	30			La. Dept. Highways		1955	133	39	1½	36-39	Qal	17.0	Aug. 1955		T, O		L, test hole to 63 feet.
Sa- 57	3	7	10	Mrs. Henry Stoker	Gerald Beasley	1953	270	100	4	?-100	Ew				D	Hard	
Sa-292	4			La. Parks Commission	Marion Tucker	1959	362	382	4	362-382	Ew	160.4	June 1959	38m	P	C	Park well.
Sa- 55	7			Henry Brown	Rex Kuhlman	1954	344	358	4, 2	132-?	Ew	90	1954	10	D	Iron	
Sa- 54	8			F. W. Marr	Rex Kuhlman		350	150	6	?-150	Ew				D	Hard; iron	
Sa-100	26			Bobby Williams		1943	410	40	30		Ewc	28.1	Nov. 1954		D	Soft	Dug well.
Sa-104	32			Frank Presley			360	29	30		Ew	24.3	Nov. 1954		D	Soft; iron	Dug well.
Sa-317	2	7	11	L. C. Delatin	Andries brothers	1959	250	186	2	166-186	Ew	56	June 1959		D		
Sa-319	2			J. L. Rivers	Wayne Jacobs	1956	285	196	2	186-196	Ew	50	1956		D	Soft	14-slot screen.
Sa-339	2			L. L. McCormic	Andries brothers	1959	290	194	2	184-194	Ew	55	Sept. 1959		D		
Sa-204	5			E. M. Campbell		1944	280	24	34		Ew	22.8	Feb. 1955		D	Soft	Dug well.
Sa-246	11			R. L. Mains	Owner	1955	250	95	4	63-95	Ew	25.1	Oct. 1955	10	D	C	Slotted casing.
Sa-238	12			Henry Brown	Rex Kuhlman	1955	340	340	4, 2	?-340	Ew			5	D	Bitter taste	
Sa- 52	13			R. L. Travis	Tuttle	1932	260	80	6	78-80	Ew	62	1954		S		
Sa-103	14			Louis Alford	E. F. Neely	1933	220	170	9⅝		Ew	8.0	Dec. 1959		O	Hard	Open-end casing.
Sa-315	14			Harold Barnhill	Osborn Miller	1959	225	130	4	110-130	Ew	13.9	Sept. 1959		D	Soft; iron	
Sa- 97	15			H. W. Andries	C. C. Burleigh	1954	230	210	4	190-210	Ew	16	Nov. 1954		D	Hard	50-slot screen.
Sa-296	17			Andries brothers	Owner	1955	240	335	4	314-335	Ew	100	1955		P	C	Supplies 7 homes.
Sa-294	21			Town of Many	Osborn Miller	1959	220	373	6⅜, 4	343-373	Ew	93	July 1959	145m	P	0.34 ppm iron	L, 16-slot screen, 6-in. diameter.
Sa-312	21			E. M. Patrick	Lewis Brooks	1954	210	126	2	118-126	Ew	4	1954		S	Soft	
Sa-194	22			Dr. A. B. Tramel	Rex Kuhlman		290	158	4	?-158	Ew	60.1	Feb. 1955	20	D	Soft; soda; iron	
Sa-311	22			E. M. Patrick	Wayne Jacobs	1957	300	156	4	136-156	Ew	103.7	Sept. 1959		D	Hard	Slotted casing.
Sa-331	22			J. E. Mowad	Andries brothers	1955	240	87	4	67-87	Ew	47.9	Sept. 1959		D	Hard; iron	Slotted casing.
Sa-332	22			Lee Grappe	Andries brothers	1956	230	160	2	?-160	Ew				D, S	Hard	
Sa- 2	27			Town of Many	Sam Holloday	1931	285	450	12, 6	404-450	Ew	131	June 1931	90	P	Soft	L, 18-slot screen, 1959 yield.
Sa- 3	27	7	11	Town of Many	Layne-Louisiana	1927	300	250	?	?-250	Ew			120	P	Soft	Test hole to 480 feet, 1959 yield.

Sa- 10	27			Town of Many	Eunice Iron Works	1950	275	450	12, 8	404-444	Ew	166	Mar. 1955	90	P	Soft	9-slot screen, 1957 yield
Sa- 11	27			Town of Many	Eunice Iron Works	1953	290	448	12¾, 8⅝	412-448	Ew	188	Mar. 1955	55	P	C	1959 yield.
Sa-289	27			Osborn Miller	Owner	1958	260	219	4	199-219	Ew			15	D	Soft	Slotted casing.
Sa-297	27			H. W. Andries		1927	305	205	4	230-250	Ew	156.6	Sept. 1959		N		
Sa-243	28			Henry Mims	Wayne Jacobs	1955	220	190	2	180-190	Ew	47	1955	8	S	Soft	L
Sa-224	32			B. D. Leslie	Gerald Beasley	1954	270	229	3	219-229	Ew	50	July 1954		D, Ir	Soft	
Sa-290	33			Mrs. Buster Nabours	Osborn Miller	1958	295	130	4	110-128	Ew	87	1958	10	D		Slotted casing.
Sa-288	35			Town of Many	H. A. Andries	1957	300	368	6	296-368	Ew	128	1957	20	P	C	1959 yield.
Sa- 18	36			David Bray, Jr.		1900	270	28	36		Ew	13.4	Sept. 1954		D	Soft; iron	Dug well. Supplies 2 families.
Sa-298	36			W. C. Alford	Andries brothers	1955	300	132	4½	?-132	Ew	41.8	Sept. 1959		D	Hard; soda taste.	
Sa-328	3	7	12	D. R. Dewitt	H. Z. Dyce	1959	320	304	2	288-304	Ew				D	Soft; soda taste.	
Sa-322	4			K. D. Cato			220	140	4	?-140	Ew	63.5	Sept. 1959		D	Bad taste	
Sa-325	4			Ray Gafford	Andries brothers	1955	260	110	2	?-110	Ew	88	1955		D	Soft; good taste	
Sa-329	4			A. A. Dewitt	Andries brothers	1955	320	206	4	?-206	Ew				D	Soda taste	Slotted casing.
Sa-327	5			Herbert Ferguson	Tom Strahan	1958	245	150	2	?-150	Ew				D	Hard	
Sa-215	6			Dr. L. H. Murdock	Wayne Jacobs	1955	182	71	8	50-71	Ew	7.4	Mar. 1955	85	Ir	Hard; iron	L
Sa-221	24			B. C. McCollister		1951	255	22	36		Ew	10.8	Mar. 1955		D	Hard	Dug well.
Sa-223	30			H. M. O'Neal		1943	220	22	45		Ew	7.5	Mar. 1955		D	Soft	Dug well.
Sa-209	5	7	13	J. H. Sepulvado		1946	210	13	30		Ew	6.1	Feb. 1955		D	Soft	Dug well.
Sa-210	2	7	14	Mrs. Lawrence Procell		1944	170	21	32		Qal	11.9	Feb. 1955		D	Soft	Dug well.
Sa-346	22			Emmett Meshell			150	?		?	Ew	Flowing	Sept. 1959	60	N		Drilled 1,000 feet for oil.
Sa- 77	1	8	10	W. P. Prothro			200	30	36		Ew	27	Nov. 1954		D	Hard; iron	Dug well.
Sa- 87	5	8	10	K. D. Berry		1938	270	21	36		Ew	19	Nov. 1954		D, S	Soft	Dug well.
Sa-345	10			Arthur Broadway	Andries brothers	1957	220	197	2	187-197	Ew				D	C	Slotted casing.
Sa- 71	14			Otis Jordan		1951	230	22	36		Ew	18	Nov. 1954		D	Hard	Dug well.
Sa- 60	24			Sam Lee	Rex Kuhlman	1953	200	126	4	?-126	Ew	17	July 1953		D, S	Soft	
Sa- 65	25			J. L. Anderson		1920	250	35	36		Ew	30	Nov. 1954		D	Hard	Dug well.
Sa- 58	34			R. R. Stoker	Randolph Grice	1951	280	192	2	?-192	Ew	98	Nov. 1954		D	Soft; soda taste	
Sa-128	27	8	11	Mt. Zion Baptist Church	Gerald Beasley	1954	350	210	4	190-210	Ew	60	Nov. 1954		D	Hard; iron	
Sa-129	27			H. A. Davidson	Owner	1953	360	160	2	Open-end casing set at 153	Ew				D	Soft	
Sa-131	27			Lonnie Ramsey	H. A. Davidson	1953	370	230	2	Open-end casing set at 130	Ew	95	Nov. 1954		D	Soft	
Sa-134	27			S. F. Webb	Wayne Jacobs	1954	340	185	4	125-185	Ew	60	Oct. 1954		D	C	
Sa-244	27			R. M. Patton	Owner	1954	330	180	4¼	?-180	Ew	62	Aug. 1955		D	Hard	
Sa-320	27			R. N. Sabell	Wayne Jacobs	1957	370	212	2	202-212	Ew	60	1957		D	Soft	14-slot screen.

TABLE 10. RECORDS OF SELECTED WELLS—Continued

Well number	Location Sec.	Location T. (N)	Location R. (W)	Owner	Driller	Year completed	Altitude (feet above sea level)	Depth (ft.)	Casing diameter (in.)	Aquifer Screened interval (in ft.)	Aquifer Stratigraphic unit	Water level Feet below land surface	Water level Date	Pump yield (gpm)	Use	Quality of water (reported)	Remarks
Sa-205	30			H. O. Seeger	Owner	1948	330	107	4	Open-end casing set at 107?	Ew	70	1948		D, S	Hard	
Sa-206	32			V. A. Ware	Wayne Jacobs	1954	300	112	4	103-112	Ew	42	Feb. 1955	4	D, S	Hard; iron	L
Sa-326	33			A. T. Barnhill	Osborn Miller	1959	340	202	2	192-202	Ew	80	1959		D	Soft	16-slot screen.
Sa-340	35			E. R. Mains	Strahan brothers	1956	260	96	4	86-96	Ew	14.8	Sept. 1959		D	Hard; iron	
Sa-200	14	8	12	Carlton Lehr	Wayne Jacobs	1954	290	153	2	145-153	Ew	50	Feb. 1955		D, S	Soft; soda taste	
Sa-202	24			R. T. Adair	Gerald Beasley	1953	330	160	2	152-160	Ew	100	Feb. 1955		D	Hard; iron	
Sa-180	31			Dr. L. H. Murdock		1942	210	145?	6	?-145	Ew			20	N	Soft; iron	L
Sa-181	31			J. O. Kimbrell, Jr.		1946	210	155?	13, 6	?-155?	Ew			20	N	C	L
Sa-247	31			G. W. Davis	Wayne Jacobs	1955	190	186	4	147-157 176-186	Ew	60	1955	20	D	Soft	
Sa-323	32			Dr. J. L. Sauls	Tom Strahan	1957	200	148	2	128-148	Ew	21	Feb. 1957		D	Hard	
Sa-324	33	8	12	W. O. Wright		1947?	220	155	4	113-155	Ew	70	1947		D	Soft	
Sa-341	34			Michael Price	Osborn Miller	1959	300	203	2	195-208	Ew	106.9	Sept. 1959		D		12-slot screen.
Sa-189	10	8	13	Noble Wood Yard	Houston Drilling Co.	1951	270	312	4	?-312	Ew				D	Iron	
Sa-190	10			Noble High School			290	300+	4	?-300+	Ew	22	1953		P, D	Soft	Slotted casing.
Sa-286	10			Mrs. C. W. Hough	Wayne Jacobs	1957	280	230	2	136-150 224-230	Ew	51	Mar. 1957	14	D		14-slot screen.
Sa-212	33			Lee Garcia	Wayne Jacobs	1954	260	191	2	179-191	Ew	32	Nov. 1954		D	Soft	L
Sa-344	35			Merritt Gray	Osborn Miller	1958	185	220	4	210-220	Ew	23.1	Sept. 1959		D	Soft; soda taste	
Sa-182	36			Town of Zwolle	Houston Drilling Co.		190	225	6	?-225	Ew			30	P		
Sa-183	36			Town of Zwolle	Houston Drilling Co.		190	225	6	?-225	Ew			30	P	C	200 feet east of Sa-182.
Sa-342	36			Town of Zwolle	Andries brothers	1958	200	205	4	185-205	Ew	55.1	Sept. 1959	80	P	C	Slotted casing.
Sa-192	36	8	14	Ebarb High School	Houston Drilling Co.	1950	270	246	2	?-246	Ew				P, D	C	
Sa-148	4	9	11	W. O. Cobb		1945	370	35	32		Ew	13.4	Dec. 1954		D	Soft	Dug well.
Sa-144	9			Methodist Holiness Camp	J. B. Dice		330	150	4	Open-end casing set at 150	Ew	75			D, S	Hard; gas	
Sa-145	15			Dewitt Jackson	Rex Kuhlman	1954	330	132	2	122-132	Ew	30	Dec. 1954	10	D, S	Soft	
Sa-291	21			W. W. Finch	Osborn Miller	1958	260	248	4	231-248	Ew	130	1958	25	D	Good	Slotted casing.

Sa-138	32			Belmont High School..	Houston Drilling Co...	1949	370	286	8, 6, 4	256-286	Ew	Flowing	1954	.....	P	C.....	Flows when not in use.
Sa-169	5	9	12	W. G. Copeland.....	Wayne Jacobs.....	1954	330	230	4	209-230	Ew	.....	.....	10	D, S	Soft; soda taste.	L
Sa-249	5			Theodore Saylor.....	Wayne Jacobs.....	1955	335	252	4	240-252	Ew	80	Aug. 1955	12	D	C.....	.....
Sa-170	6			P. A. Henderson.....	Owner.....	1954	330	235	4	?-235	Ew	90	Jan. 1955	.....	D	Soft; soda taste.	Slotted casing.
Sa-160	2	9	13	Julian Burkett.....	Wayne Jacobs.....	1955	290	328	4	298-328	Ew	90.2	Jan. 1955	12	D	Soft; soda taste.	L; slotted casing.
Sa-166	2			R. L. Patrick.....	Gerald Beasley.....	1954	280	189	4	177-189	Ew	30	Jan. 1955	.....	D, S	Soft.....	.....
Sa-348	8			J. W. Powell.....	George Brasher.....	1956	250	125	4	?-125	Ew	.....	.....	.....	D	C.....	.....
Sa- 13	10			S. B. Evans.....	R. P. Bufkin.....	.....	220	250	6	?-250	Ew	18	Feb. 1954	20	P	C.....	Slotted casing.
Sa-350	10	9	13	S. B. Evans.....	George Brasher.....	1957	220	250	4	210-250	Ew	20	1957	20	P	.....	Slotted casing.
Sa-155	10			Kansas City Southern Railway	.....	1942	210	100	12	85-100	Ew	20	Dec. 1954	.....	I	Hard; iron.....	.....
Sa-162	12			Oak Grove School.....	Bihm Drilling Co.....	1954	305	226	4, 2	214-226	Ew	84	.....	.....	P	Hard ;iron.....	.....
Sa-163	12			Oak Grove School.....	.....	1936	305	200	6	?-200	Ew	86.7	Dec. 1959	10	O	Hard; iron.....	Slotted casing.
Sa-250	12			Mrs. Maybelle Burkett.	Wayne Jacobs.....	1955	275	225	4	215-225	Ew	.....	.....	12	D	Soft.....	L
Sa-184	16			R. R. McDonald.....	J. J. Burkett.....	1949	260	235	4½	?-235	Ew	60	Feb. 1955	7	D	Soft; soda taste.	.....
Sa-178	24			L. V. Ford.....	.....	1900	280	30	42	.....	Ew	16.5	Jan. 1955	.....	D	Soft.....	.....
Sa- 9	19	10	11	R. O. Martin Lbr. Co..	L. P. Blevins.....	1943	310	215	9⅞	145-155 175-215	Ew	.....	.....	.....	A	.....	L; test hole depth 500 feet.
Sa-153	23			J. W. Bowden.....	Bell.....	.....	320	185	4, 2	177-185	Ew	80	Dec. 1954	4	D	Hard.....	.....
Sa-152	29			Dr. H. M. Prothro....	R. P. Bufkin.....	1944	295	250	6	235-250	Ew	80	Dec. 1954	.....	N	C.....	.....
Sa-248	29			Village of Pleasant Hill.	B. F. Edington.....	1955	295	502	8⅝	412-502	Ew	113.9	Sept. 1959	140 m	P	C.....	L
Sa-147	32			A. P. Britt & A. L. Pender	Rex Kuhlman.....	1954	310	210	2	202-210	Ew	116	Sept. 1954	5	D	Soft.....	.....
Sa-149	32			Pleasant Hill High School	L. B. Clifford.....	1928	310	200	6	?-200	Ew	90.5	Jan. 1960	.....	P	Soft; soda taste.	Test hole depth 366 feet.
Sa-150	32			J. H. Emmons.....	L. P. Blevins.....	1935	310	520	6	?-520	Ew	180	Dec. 1954	3	D	Soft.....	Old C. C. C. camp.
Sa-151	33			Cliff Ashby.....	R. P. Bufkin.....	1944	310	184	4	166-184	Ew	115	1944	.....	A	Soft; soda taste.	.....
Sa-157	33	10	12	V. H. Brumley.....	Wayne Jacobs.....	1954	270	168	8, 4	108-168	Ew	60	July 1954	40	S	Soft.....	Slotted casing.
Sa-165	25	10	13	Preston Barron.....	.....	1921	280	41	36	.....	Ew	40	Jan. 1955	.....	D	Soft.....	Dug well.
Sa-156	27			Hughes Patrick.....	W. M. Brummett.....	1952	230	115	4	?-115	Ew	30	Feb. 1955	15	D, Ir	Soft.....	.....
Sa-174	27	10	14	Oliver Price.....	.....	1920	210	30	36	.....	Ew	22.4	Jan. 1955	.....	D	Soft.....	Dug well.

TABLE 11. CHEMICAL ANALYSES OF WATER FROM SELECTED WELLS IN SABINE PARISH

(Stratigraphic unit: Mc, Catahoula Formation; Ecc, Cockfield Formation; Ecs, Sparta Sand; Ew Wilcox Group. Agency making analysis: U.S. Geological Survey)

Well No.	Location: Section	Location: T., N.	Location: R., W.	Date of collection	Results in parts per million: Silica (SiO_2)	Iron (Fe) total	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids (Residue at 180°C)	Hardness as $CaCO_3$ (Calcium, magnesium)	Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	Color	pH	Temperature (°F)	Stratigraphic unit
Sa- 8	23	6	11	3-12-57	28	0.63	0.01	6.6	3.8	10	2.4	0	42	9.6	8.8	0.1	0.8	0.00	0.00	90	32	38	0.8	120	0	6.1	70	Ecs
Sa- 11	27	7	11	2- 2-54	14	.66	.01	1.2	.6	364	1.5	24	880	.1	25	2.0	.2	3.6	1.0	894	6	99	.....	1,410	110	8.5	73	Ew
Sa- 13	10	9	13	2- 2-54	13	.10	.00	1.4	.6	214	1.1	8	516	.5	25	1.5	.5	2.9	1.4	527	6	98	.....	854	45	8.5	68	Ew
Sa- 31	2	5	11	2- 4-55	56	1.9	.20	14	4.6	30	3.8	0	109	13	16	.1	.2	.52	.10	203	54	53	.....	262	0	7.6	....	Ecs
Sa- 32	26	6	12	2- 4-55	16	.16	.00	1.2	.3	533	1.9	47	1,280	.1	23	3.6	.5	5.6	.....	1,300	4	98	.....	2,030	140	8.5	....	Ew
Sa-134	27	8	11	2- 3-55	22	4.2	.....	188	123	426	9.2	0	446	1,080	322	.1	9.9	.24	.....	2,570	975	48	.....	3,320	5	7.6	....	Ew
Sa-138	32	9	11	3-26-56	25	4.4	.08	71	36	172	6.5	0	228	252	184	.1	3.6	.02	.38	901	325	53	4.1	1,420	0	6.8	....	Ew
Sa-152	29	10	11	2- 3-55	14	.05	.01	2.2	.1	306	.9	20	693	20	32	1.5	3.5	2.1	.00	751	6	99	.....	1,200	40	8.4	....	Ew
Sa-181	31	8	12	2-14-55	39	3.4	.00	11	4.8	64	1.0	0	179	3.3	28	.3	.8	.15	.27	241	48	74	.....	385	10	7.3	68	Ew
Sa-183	36	8	13	2-14-55	36	1.0	.00	24	10	110	1.9	0	317	14	49	.8	1.2	.79	.39	406	102	70	.....	662	5	7.8	69	Ew
Sa-192	36	8	14	2-24-55	40	6.6	.20	5.0	.2	28	2.2	0	96	2.1	7.2	.2	.2	.08	.07	138	24	70	.....	184	35	7.5	....	Ew
Sa-213	27	6	10	2-24-55	38	6.8	.20	20	15	35	6.0	0	156	45	17	.4	.2	.26	.09	290	111	39	.....	395	15	7.1	....	Ecc
Sa-228	22	5	10	10-19-55	39	1.1	.10	2.1	.2	7	1.7	0	16	6.4	4.2	.1	.0	.00	.19	71	6	66	.....	57	0	6.6	....	Mc
Sa-233	18	5	12	3-26-56	36	6.4	.03	5.2	2.2	44	2.1	0	116	.2	16	.3	.7	1.5	.14	183	22	79	4.1	240	120	6.8	68	Ew
Sa-246	11	7	11	10-20-55	33	10	.20	21	7.0	18	1.2	0	125	5.6	10	.2	.2	.00	.27	154	81	32	.....	232	0	6.9	69	Ew
Sa-248	29	10	11	10-18-55	11	.84	.00	3.2	.3	251	1.7	12	580	3.7	43	.8	1.2	1.3	.80	640	9	98	.....	1,010	45	8.4	71	Ew
Sa-249[1]	5	9	12	10-18-55	55	3.1	.02	25	3.7	70	3.9	0	255	17	22	.4	.2	.01	.27	328	78	65	.....	477	0	7.5	71	Ew
Sa-287	28	5	10	12-17-58	89	.41	.01	2.0	.2	29	2.5	0	66	5.0	9.3	.1	.1	.40	.06	173	6	88	5.3	152	30	6.5	70	Ecc
Sa-288	35	7	11	8- 7-59	12	.26	.01	.0	.0	361	1.0	35	823	2.8	32	2.0	.2	2.5	2.7	909	0	99	.....	1,390	120	8.7	....	Ew
Sa-292	4	7	10	6-29-59	11	.24	.01	1.7	.4	225	1.0	19	439	56	33	.4	.2	1.9	.61	572	6	99	40	905	30	8.6	74	Ew
Sa-295	2	6	11	8-27-59	13	7.6	.00	1.6	1.0	570	3.1	46	1,290	1.4	70	11	1.0	.10	7.0	1,430	8	99	88	2,180	200	8.6	77	Ew
Sa-296	17	7	11	8-27-59	11	2.5	.01	1.2	.5	248	2.3	25	463	78	26	.8	.6	.10	1.3	648	5	99	48	1,010	120	8.8	72	Ew
Sa-303	18	6	10	3-10-60	52	3.9	.02	6.0	1.2	28	4.2	0	90	1.8	7.0	.2	.2	.00	.03	145	20	70	2.7	178	50	6.6	....	Ecs
Sa-308	10	6	10	9-24-59	35	8.5	.01	26	5.4	26	2.2	0	141	16	10	.2	.0	.0	.00	191	87	39	1.2	287	10	6.6	....	Ecs
Sa-310	27	6	10	3-10-60	13	.62	.00	.0	.0	193	1.2	17	422	24	14	.7	.8	1.7	.42	474	0	99	.....	774	60	8.7	....	Ecc
Sa-321	2	5	11	3-10-60	52	16	.20	52	23	86	7.8	0	148	149	102	.3	.1	0	.16	546	222	45	2.5	838	10	6.8	....	Ecc
Sa-342	36	8	13	9-21-59	30	.97	.03	29	6.0	225	2.0	0	476	12	131	2.8	.1	1.0	.90	678	97	83	9.9	1,120	20	7.8	69	Ew
Sa-345	10	8	10	9-24-59	11	.04	.04	2.9	1.2	409	2.0	28	629	254	52	1.4	2.5	1.6	1.85	1,160	12	98	51	1,730	40	8.6	....	Ew
Sa-348	8	9	13	9-25-59	50	3.2	.04	4.2	5.5	52	1.3	0	40	5.6	74	.4	3.3	.1	.06	242	33	77	3.9	343	30	6.3	....	Ew
Sa-349	13	5	13	9-25-59	22	.49	.01	5.2	.7	6	.8	0	23	5.4	3.6	.1	.1	.1	0	59	16	42	.6	68	30	5.9	....	Ecs

[1]Water from well Sa-249 had aluminum content of 3.6 ppm and a carbon dioxide content of 13 ppm.

TABLE 12. SELECTED LOGS OF WATER WELLS IN SABINE PARISH

Sa-2. Sec. 27, T. 7 N., R. 11 W. Altitude 285 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Shale and gumbo	100	100	Gumbo, rock, and shale	106	400
Shale and sand	194	294	Sand	50	450

Sa-9. Sec. 19, T. 10 N., R. 11 W. Altitude, 310 feet.

Wilcox Group			Wilcox Group—Contd.		
Soil	1	1	Sand	40	215
Clay, sandy, yellow	14	15	Shale	3	218
Sand	9	24	Rock	1	219
Gumbo, soft	6	30	Gumbo	11	230
Sand	15	45	Shale, sandy	40	270
Rock	1	46	Rock	1	271
Shale	9	55	Shale, sandy	55	326
Gumbo, blue	26	81	Rock	1	327
Rock	1	82	Gumbo	13	340
Shale	1	83	Sand, fine	15	355
Rock	1	84	Rock	1	356
Shale, soft	30	114	Shale, hard	28	384
Rock	2	116	Shale, sandy	24	408
Shale, with layers of rock	4	120	Sand, fine	12	420
Shale, hard	5	125	Shale, soft	35	455
Rock	2	127	Shale, hard	5	460
Shale	12	139	Shale, hard, and lignite	7	467
Sand, gray	16	155	Gumbo	18	485
Sand, with shale stringers	20	175	Shale, hard	15	500

Sa-121. Sec. 32, T. 6 N., R. 9 W. Altitude, 420 feet.

Catahoula Formation			Catahoula Formation—Contd.		
Sand, medium	85	85	Sand, coarse	15	100

Sa-160. Sec. 2, T. 9 N., R. 13 W. Altitude, 290 feet.

Wilcox Group			Wilcox Group—Contd.		
Shale	80	80	Sand, fine	15	255
Sand and lignite	13	93	Lime and shale	10	265
Shale	71	164	Rock and shale	16	281
Sand	16	180	Sand	9	290
Rock (sandstone)	12	192	Shale	8	298
Shale, sandy	12	204	Sand, coarse (?), very compact	30	328
Sand	16	220			
Shale	20	240			

Sa-169. Sec. 5, T. 9 N., R. 12 W. Altitude, 330 feet.

Wilcox Group			Wilcox Group—Contd.		
Soil, clay, gumbo	21	21	Shale	10	190
Sand	7	28	Sand, fine, grading to medium	40	230
Shale	112	140			
Shale, sandy	40	180			

TABLE 12. SELECTED LOGS OF WATER WELLS IN SABINE PARISH—Continued

Sa-180. Se,. 31, T. 8 N., R. 12 W. Altitude, 210 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Surface clay	13	13	Sand	7	167
Sand	12	25	Shale, hard	16	183
Shale, sandy	47	72	Shale	12	195
Rock	1	73	Sand	35	230
Sand	72	145	Shale	5	235
Shale	10	155	Shale, hard	12	247
Shale	5	160			

Sa-181. Sec. 31, T. 8 N., R. 12 W. Altitude, 210 feet.

Wilcox Group			Wilcox Group—Contd.		
Surface clay	12	12	Shale, brown	76	231
Sand, fine, white	18	30	Sand, fine, dark	11	242
Shale, gray	41	71	Shale, brown	14	256
Sand, gray, water	84	155	Rock, hard	0.5	256.5

Sa-206. Sec. 32, T. 8 N., R. 11 W. Altitude, 300 feet.

Wilcox Group			Wilcox Group—Contd.		
Shale and clay	40	40	Shale	34	84
Sand	10	50	Sand, coarse (?)	14	98

Sa-212. Sec. 33, T. 8 N., R. 12 W. Altitude, 260 feet.

Wilcox Group			Wilcox Group—Contd.		
Surface material	26	26	Shale	144	179
Sand	9	35	Sand	12	191

Sa-215. Sec. 6, T. 7 N., R. 12 W. Altitude, 182 feet

Wilcox Group			Wilcox Group—Contd.		
Surface shale	40	40	Sand, fine, gray	20	71
Shale, sandy, with lignite	11	51			

Sa-225. Sec. 26, T. 6 N., R. 12 W. Altitude 210 feet.

Wilcox Group			Wilcox Group—Contd.		
Surface	16	16	Shale	103	126
Sand	7	23	Sand	9	135

Sa-242. Sec. 17, T. 6 N., R. 10 W. Altitude, 290 feet.

Sparta Sand			Sparta Sand—Contd.		
Soil	10	10	Shale	25	60
Quicksand	17	27	Sand, white	30	90
Shale	8	35			

TABLE 12. SELECTED LOGS OF WATER WELLS IN SABINE PARISH—Continued

Sa-243. Sec. 28, T. 7 N., R. 11 W. Altitude, 220 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Surface	15	15	Shale, sandy	35	165
Lignite, broken	10	25	Sand, fine, grading to coarse (?)	25	190
Sand	5	30			
Shale	100	130			

Sa-248. Sec. 29, T. 10 N., R. 11 W. Altitude, 295 feet.

Wilcox Group			Wilcox Group—Contd.		
Surface	3	3	Shale	4	258
Clay	12	15	Sand, lignite, and shale	10	268
Sand	7	22	Shale	5	273
Shale	28	50	Sand	12	285
Sand	21	71	Shale	31	316
Shale	22	93	Lignite	2	318
Sand	12	105	Sand	12	330
Shale	15	120	Shale	18	348
Sand	11	131	Shale, sandy	8	356
Shale	10	141	Shale	11	367
Rock	1	142	Rock	5	372
Shale	3	145	Shale	43	415
Sand	19	164	Sand	69	484
Shale	18	182	Lignite	2	486
Sand	4	186	Sand	21	507
Shale	10	196	Lignite and shale	3	510
Rock	1	197	Sand	8	518
Shale, black	17	214	Rock	3	521
Sand	11	225	Sand, hard, gray	41	562
Shale	28	253	Shale, sandy	13	575
Rock	1	254	Shale	25	600

Sa-250. Sec. 12, T. 9 N., R. 13 W. Altitude, 275 feet.

Wilcox Group			Wilcox Group—Contd.		
Shale	60	60	Sand, lignitic, fine	16	180
Sand	20	80	Rock, broken	10	190
Shale, limy	13	93	Shale, sandy	20	210
Shale	71	164	Sand, white, medium	15	225

Sa-251. Sec. 23, T. 6 N., R. 10 W. Altitude, 340 feet.

Cockfield Formation			Cockfield Formation—Contd.		
Clay	3	3	Sand, fine, gray	15	110
Shale	92	95			

TABLE 12. SELECTED LOGS OF WATER WELLS IN SABINE PARISH—Continued

Sa-292. Sec. 4, T. 7 N., R. 10 W. Altitude, 362 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Sand and clay interbedded...	15	15	Sand, very fine, dark.....	22	248
Sand, fine, lignitic.....	33	48	Sand, fine, dark.....	7	255
Sand, medium, dark.....	2	50	Rock and clay, dark gray....	20	275
Clay, blue, and rock.....	7	57	Clay, black, greasy.....	12	287
Sand, very fine, black.....	3	60	Lignite, wood, and clay.....	8	295
Clay, blue.....	15	75	Sand, fine, gray, with lignite.	9	304
Lignite.....	1	76	Clay, gray.....	16	320
Sand, very fine, dark gray, lignitic.....	9	85	Clay, gray, with sand streaks (scattered shells 320-325)	10	330
Clay, silty, gray, soft.....	5	90	Sand, very fine, with clay streaks.....	5	335
Silt, black.....	5	95	Sand, very fine to fine, gray..	60	395
Clay, grey.....	25	120	Sand, very fine, with some clay.....	5	400
Shells and thin rock bed.....	5	125	Clay, gray, and silt.....	10	410
Clay, blue.....	10	135	Silt, light gray.....	20	430
Sand, very fine, dark (rock at 150).....	15	150	Sand, very fine, light gray...	7	437
Clay, blue to gray.....	57	207	Lignite bed.....	3	440
Rock.....	1	208	Silt, gray, and very fine sand.	10	450
Clay, gray.....	15	223	Clay, gray (with sand streaks 450-455).....	23	473
Rock.....	1	224			
Clay, blue.....	2	226			

Sa-294. Sec. 21, T. 7 N., R. 11 W. Altitude, 220 feet.

Wilcox Group			Wilcox Group—Contd.		
Sand and clay.....	30	30	Rock.....	1	220
Lignite.....	5	35	Shale, sandy.....	10	230
Clay with sand streaks.....	100	135	Rock.....	1.5	231.5
Lignite, sand, and clay.....	71	206	Shale.....	94.5	326
Sand.....	10	216	Sand.....	72	398
Rock.....	1	217	Sand and shale.....	3	401
Shale, sandy.....	2	219			

TABLE 13. LOGS OF TEST BORINGS

Sa-252. Sec. 30, T. 6 N, R. 13 W. Altitude, 140 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Quaternary Alluvium			Quaternary alluvium—Contd.		
Soil, sandy clay	4	4	Sand, medium, gray	5	32
Clay	9	13	Sand, yellow	4	36
Sand, fine	5	18	Wilcox Group		
Sand	8	26	Clay, plastic, gray	2	38
Clay, plastic, gray	1	27	Sand, silty	10	48

Sa-253. Sec. 30, T. 6 N., R. 13 W. Altitude, 133 feet.

Quaternary alluvium			Quaternary alluvium—Contd.		
Clay	3.5	3.5	Sand, coarse, gray	3	32
Clay, sandy	5	8.5	Wilcox Group		
Sand	1.5	10	Clay, hard, gray	4	36
Clay, plastic	3	13	Sand, medium, gray	8	44
Sand, silty; brown	4	17	Clay, hard, gray	19	63
Sand, medium, brown	12	29			

Sa-254. Sec. 29, T. 6 N., R. 12 W. Altitude, 142 feet.

Quaternary alluvium			Wilcox Group		
Soil and clay, brown to gray	3.5	3.5	Clay, hard, dark gray	4	42
Clay, red	2.5	6			
Sand, gray, dry	32	38			

Sa-255. Se,. 29, T. 6 N., R. 13 W. Altitude, 145 feet.

Quaternary alluvium			Quaternary alluvium—Contd.		
Soil, sandy, fine, yellow	3.5	3.5	Clay, light gray	1	9
Sand, fine, yellow	1.5	5	Sand, fine, gray	22	31
Clay, light gray	1	6	Wilcox Group		
Silt, sandy, yellow	1	7	Clay	16	47
Silt, clayey and sandy	1	8			

Sa-256. Sec. 28, T. 6 N., R. 13 W. Altitude, 146 feet.

Quaternary alluvium			Quaternary alluvium—Contd.		
Loam, yellow	3	3	Sand, fine, gray	7	30
Clay, light gray	9	12	Wilcox Group		
Clay, plastic, yellow	8	20	Clay, black	7	37
Sand, silty, gray-blue	3	23			

Sa-257. Sec. 28, T. 6 N., R. 13 W. Altitude, 180 feet.

Wilcox Group			Wilcox Group—Contd.		
Soil; clayey silt, buff	5	5	Clay, brown	14	24
Clay, silty, becoming more clayey	5	10	Silt, sandy	1	25
			Shale, dark gray	3	28

Sa-258. Sec. 20, T. 10 N., R. 11 W. Altitude, 343 feet.

Wilcox Group			Wilcox Group—Contd.		
Soil; clay, reddish-orange to red	7	7	Clay, light gray	9	22
Clay, light gray	2	9	Shale, gray, plastic with very fluid silty fine sand	65	87
Clay, tan	4	13			

TABLE 13. LOGS OF TEST BORINGS—Continued

Sa- 259. Sec. 20, T. 10 N., R. 11 W. Altitude, 225 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Soil; silt, gray, moist	4	4	Sand, silty tan	8	25
Sand, very fine, yellow	4	8	Clay, dark gray, with sand stringers	10	35
Sand, fine, yellow	4	12	Sand	52	87
Clay, silty	5	17			

Sa-260. Sec. 21, T. 9 N., R. 11 W. Altitude, 260 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Quaternary alluvium			Quaternary alluvium—Contd.		
Soil; clayey subsoil	3.5	3.5	Sand stringers	1	17
Clay, brown	11.5	15	Wilcox Group		
Clay, gray	1	16	Clay, gray	28	45
			Clay, gray, very hard (shale)	5	50

Sa-261. Sec. 5, T. 8 N., R. 11 W. Altitude, 320 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Clay, red	4	4	Clay, gray, plastic	20	43
Clay, yellow	2	6	Clay, gray, very hard	1	44
Clay, gray	14	20	Sand, fine, silty	32	76
Clay, gray, hard	3	23	Clay	2	78

Sa-262. Sec. 21, T. 8 N., R. 11 W. Altitude, 360 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Soil; clay, red	6	6	Clay, gray	10	23
Clay, tan, yellow and gray, plastic	7	13	Clay, sandy	15	38
			Clay, hard	5	43

Sa-263. Sec. 33, T. 8 N., R. 11 W., Altitude, 330 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Soil; clay, red	3	3	Clay, dark gray, hard	18	38
Clay, tan	3	6	Clay, gray, plastic	9	47
Clay, tan	14	20			

Sa-264. Sec. 16, T. 7 N., R. 11 W. Altitude, 260 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Soil; clay, red	4	4	Clay, dark gray	39	84
Sand, fine, yellow	41	45			

Sa-265. Sec. 35, T. 7 N., R. 11 W. Altitude, 286 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Wilcox Group			Wilcox Group—Contd.		
Clay, red	2	2	Clay, gray, hard	20	35
Clay, tan	13	15	Sand, silty, gray	13	58

TABLE 13. LOGS OF TEST BORINGS—Continued

Sa-266. Sec. 11, T. 6 N., R. 11 W. Altitude, 382 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Carrizo (?) Sand			Carrizo (?) Sand—Contd.		
Surface; clay, red	4	4	Clay, light gray, tough	8	33
Sand, fine, yellow	2	6	Sand, yellow	12	45
Clay, red	11	17	Sand, yellow	29	74
Sand, yellow	8	25			

Sa-267. Sec. 23, T. 6 N., R. 11 W. Altitude, 320 feet.

Cook Mountain Formation			Cook Mountain Formation—Contd.		
Soil; clay, red	10	10	Clay, dark gray	9	39
Clay, brown	20	30	Glauconite, very hard	.....	39

Sa-268. Sec. 12, T. 5 N., R. 11 W. Altitude, 230 feet.

Cockfield Formation			Cockfield Formation—Contd.		
Surface soil	1	1	Sand, fine, light gray	32	38
Sand, fine, silty	1	2	Silt and clay	10	48
Clay, tan	4	6			

Sa-269. Sec. 24, T. 5 N., R. 11 W. Altitude, 240 feet.

Jackson Group			Jackson Group—Contd.		
Surface	2	2	Clay, tan, with iron concretions	14	50
Clay, red	2	4	Clay, dark gray	24	74
Clay, tan	32	36			

Sa-270. Sec. 31, T. 5 N., R. 10 W. Altitude, 220 feet.

Vicksburg Group			Vicksburg Group—Contd.		
Surface; clay, red	2	2	Clay, dark greenish-gray	51	74
Clay, tan, with iron streaks	21	23			

Sa-271. Sec. 8, T. 4 N., R. 10 W. Altitude, 260 feet.

Catahoula Formation			Catahoula Formation—Contd.		
Sand, gray	6	6	Clay, green, hard	25	48
Sand, light blue, hard-packed	17	23			

Sa-272. Sec. 13, T. 5 N., R. 11 W. Altitude, 240 feet.

Jackson Group			Jackson Group—Contd.		
Clay, brown	6	6	Clay, greenish-gray	5	35
Clay, yellow	24	30	Marl (?), green, fossiliferous	28	63

Sa-273. Sec. 25, T. 5 N., R. 11 W. Altitude, 209 feet

Jackson Group			Jackson Group—Contd.		
Fill	10	10	Clay, dark gray	53	78
Sand, yellow (alluvial ?)	15	25			

TABLE 13. LOGS OF TEST BORINGS—Continued

Sa-274. Sec. 30, T. 6 N., R. 13 W. Altitude, 120 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Quaternary alluvium			Quaternary alluvium—Contd.		
Soil, silty	5	5	Sand, with clay streaks	36	47
Silt, clayey	6	11			

Sa-275. Se,. 12, T. 6 N., R. 13 W. Altitude, 153 feet.

Wilcox Group			Wilcox Group—Contd.		
Sand, fine, yellow	25	25	Sand	3	43
Sand, fine, gray	12	37	Clay, with some soft		
Clay, dark gray	3	40	(sand ?) zones	36	79

Sa-276. Sec. 24, T. 7 N., R. 13 W. Altitude, 220 feet.

Wilcox Group			Wilcox Group—Contd.		
Fill, sand, fine, silty, orange	3	3	Clay, dark gray	1	16
Clay, laminated, tan with			Silt, sandy, dark gray	9	25
iron streaks	5	8	Clay, dark gray	44	69
Sand, fine, silty, white	7	15			

Sa-277. Sec. 21, T. 4 N., R. 12 W. Altitude, 160 feet.

Cockfield Formation			Cockfield Formation—Contd.		
Sand, fine, white	5	5	Sand, gray	12	18
Clay, sandy	1	6	Clay, dark gray	61	79

Sa-278. Sec. 16, T. 7 N., R. 14 W. Altitude, 140 feet.

Quaternary alluvium			Quaternary alluvium—Contd.		
Surface silt	3	3	Sand	45	53
Silt, sandy	5	8			

Sa-279. Sec. 5, T. 7 N., R. 14 W. Altitude, 140 feet.

Quaternary alluvium			Wilcox Group		
Silt	3	3	Clay	8	35
Clay, silty	5	8	Rock, very hard	9	44
Sand	19	27			

Sa-280. Sec. 20, T. 8 N., R. 14 W. Altitude 140 feet

Quaternary alluvium			Quaternary alluvium—Contd.		
Surface silt and clay	4	4	Sand, gray	10	40
Sand, yellow	16	20	Wilcox Group		
Sand, brown	6	26	Clay, light gray	5	45
Sand, white	4	30			

TABLE 13. LOGS OF TEST BORINGS—Continued

Sa-271. Sec. 3, T. 8 N., R. 14 W. Altitude, 160 feet.

Material	Thickness feet	Depth feet	Material	Thickness feet	Depth feet
Quaternary alluvium			Quaternary alluvium—Contd.		
Clay and silt	5	5	Sand, yellow	13	43
Clay, yellow	7	12	Wilcox Group		
Clay, gray	18	30	Clay, dark gray	10	53

Sa-282. Sec. 29, T. 9 N., R. 14 W. Altitude 156 feet

Quaternary alluvium			Quaternary alluvium—Contd.		
Sand, fine to-medium, light tan	10	10	Sand, light	5	25
Clay	1	11	Sand, gray	15	40
Sand, fine, yellow	9	20	Wilcox Group		
			Clay, dark gray	7	47

Sa-284. Sec. 11, T. 4 N., R. 13 W. Altitude, 130 feet.

Quaternary alluvium			Wilcox Group		
Clay, silty	5	5	Clay	38	58
Sand	15	20			

TABLE 14. GAGING STATION RECORDS, SABINE RIVER AT LOGANSPORT, LA.

Location—Lat 31°59′, long 94°01′, in NE¼ sec. 4, T. 11 N, R. 16 W., at Logansport, DeSoto Parish on left bank 4,600 ft. upstream from bridge on U. S. Highway 84, 4,800 ft. upstream from Texas and New Orleans Railroad Co. bridge, 4 miles upstream from Bayou Castor, and at mile 268.

Drainage area—4,858 sq. mi.

Supplemental records available—Gage height records collected at site 4,600 ft. downstream since 1903 are contained in reports of U. S. Weather Bureau; used by Geological Survey 1903-05, corrected to datum of Geological Survey gage.

Gage—Water-stage recorder used for gage-heights below 24 ft., and supplementary wire-weight gage 4,600 ft. downstream (used as regular gage Feb. 14, 1941 to Sept. 30, 1956) used for gage heights above 24 ft. Datum of gage is 147.72 ft. above mean sea level, datum of 1929. July 1, 1903 to Dec. 31, 1906, chain gage at site of supplementary gage at present datum.

Average discharge—52 years (1903-19, 1922-58), 3,267 cfs (2,365,000 acre-ft per year).

Extremes—1903-1958: Maximum discharge, 92,000 cfs Apr. 8, 1945 (gage height, 44.07 ft. at site of supplementary gage, from floodmark); minimum observed during periods of daily records, 16 cfs Sept. 26-28, Oct. 3, 4, 1939.
Maximum stage known since at least 1884, that of Apr. 8, 1945. Flood in May 1884 reached a stage of 39.4 ft., present datum, at site of supplementary gage.

Remarks—Diversions above station for oil field operation and municipal and industrial use. Jan. 1907 to Sept. 1923, monthly records only.

SABINE RIVER AT LOGANSPORT, LA.
Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,590	1,430	242	.....
1904	1,170	558	465	470	893	988	4,570	2,060	1,940	884	345	196	1,210
1905	104	107	2,012	2,770	6,280	7,374	9,650	19,350	10,590	13,270	4,139	441	6,352
1906	610	3,130	6,406	12,650	5,300	4,330	7,978	3,590	3,700	1,130	2,000	955	4,311
1907	1,350	429	3,980	5,710	1,520	3,210	1,980	8,120	7,440	932	161	85.6	2,930
1908	127	4,090	7,050	4,690	7,550	4,000	3,380	14,410	5,327	456	622	763	4,366
1909	527	337	823	827	2,700	2,140	1,120	507	450	111	63.6	45.1	792
1910	105	86.1	1,060	1,020	1,620	2,280	3,400	2,230	505	494	73.3	43.6	1,070
1911	33.9	35.5	97.6	313	348	502	3,350	2,020	132	1,010	187	84.0	675
1912	80.8	83.6	1,430	1,830	1,110	6,780	9,138	2,900	522	447	5,100	680	2,515
1913	97.6	94.5	225	824	1,740	6,760	3,740	1,070	439	3,750	193	2,140	1,760
1914	4,450	668	9,240	3,610	4,880	4,020	8,010	17,470	3,260	240	642	503	4,767
1915	237	300	3,060	6,210	8,501	7,630	4,199	15,950	1,260	2,170	6,250	4,620	5,030
1916	831	1,930	1,660	3,610	7,824	1,130	3,770	7,270	991	702	274	207	2,497
1917	132	390	699	1,190	2,420	2,040	1,340	868	1,120	1,170	427	631	1,030
1918	307	143	230	457	379	356	2,390	4,530	859	175	183	337	865
1919	197	1,150	3,190	6,530	4,990	4,220	3,720	1,790	2,280	4,590	3,630	2 300	3,210
1920	10,680	16,790	7,120	10,370	6,090	6,300	4,990	3,880	3,520	1,130	2,000	1,600	6,200

1921	800	1,200	2,500	6,275	4,057	5,249	10,900	8,663	2,063	3,673	329	252	3,830
1922	124	154	546	1,250	2,520	9,300	17,760	12,340	2,602	1,262	432	192	4,040
1923	96.6	688	539	1,118	6,180	6,193	7,491	3,157	2,575	475	86.7	881	2,421
1924	504	494	5,610	8,780	5,510	8,020	4,490	4,040	4,590	155	122	174	3,540
1925	124	99.6	216	821	521	542	498	1,820	219	78.5	47.3	100	425
1926	386	5,180	734	3,190	2,170	7,360	10,500	7,540	1,680	2,930	1,630	174	3,630
1927	263	510	2,970	4,720	5,310	8,870	11,500	5,970	1,810	1,520	1,260	118	3,720
1928	1,790	354	738	887	1,520	4,480	4,360	3,180	2,310	1,560	699	75.1	1,830
1929	190	1,450	4,670	9,420	5,870	5,440	2,840	4,990	7,470	573	80.0	338	3,600
1930	104	550	996	6,090	6,360	3,470	938	10,300	8,010	219	102	89.9	3,080
1931	500	470	3,060	3,000	2,410	5,040	2,130	3,890	756	363	183	164	1,840
1932	40.6	300	7,510	20,600	19,400	11,500	3,100	1,810	368	503	110	142	5,420
1933	95.2	103	724	7,000	5,280	7,480	6,100	5,060	2,160	5,730	2,260	406	3,530
1934	244	263	628	4,680	3,140	9,570	9,260	1,260	450	92.9	29.2	34.6	2,470
1935	39.8	663	2,693	2,883	6,835	3,009	2,143	17,490	5,364	2,680	205	234	3,678
1936	515	2,143	3,840	1,006	1,084	1,281	465	2,352	421	639	68.0	39.6	1,159
1937	1,044	603	1,344	7,874	4,972	6,632	4,226	648	401	122	103	167	2,334
1938	177	1,287	3,115	10,150	13,140	6,314	11,220	6,044	606	347	547	67.7	4,358
1939	41.0	409	460	3,842	6,500	6,636	2,346	1,297	491	209	38.4	23.3	1,831
1940	19.5	87.4	1,677	800	4,176	935	3,505	2,402	4,226	2,301	453	1,168	1,795
1941	223	7,123	15,890	12,600	5,498	9,297	4,444	8,676	8,316	6,689	736	1,018	6,735
1942	1,767	5,150	4,449	2,754	2,991	4,703	12,250	16,590	7,305	909	1,910	2,467	5,273
1943	498	915	1,185	4,107	1,427	1,558	3,105	1,554	12,490	1,540	131	82.2	2,371
1944	990	347	1,116	6,315	7,066	10,460	9,517	25,470	7,044	379	132	375	5,776
1945	140	570	3,646	14,620	6,049	21,400	34,410	2,829	5,021	9,470	936	308	8,282
1946	4,431	1,958	3,403	12,280	15,620	11,730	5,631	8,673	19,930	1,082	350	885	7,096
1947	572	11,220	6,868	7,758	4,884	7,488	8,176	5,320	1,361	754	142	601	4,585
1948	201	1,154	5,391	6,857	10,090	9,497	3,390	6,816	2,652	424	183	99.8	3,885
1949	91.9	360	548	3,117	6,395	7,143	4,509	3,580	1,714	1,981	1,465	556	2,600
1950	4,276	3,593	1,727	10,680	17,950	7,704	2,229	11,380	6,953	1,601	1,703	1,107	5,836
1951	527	540	495	1,535	4,279	3,848	2,021	1,216	1,930	678	105	193	1,427
1952	94.6	253	843	1,458	5,997	4,331	6,447	6,451	4,000	227	102	40.8	2,500
1953	37.1	119	2,214	2,332	3,816	6,997	2,626	22,310	4,892	1,270	546	496	3,993
1954	97.0	370	2,071	2,771	2,972	1,182	1,476	4,914	852	83.1	34.5	22.3	1,399
1955	142	2,592	1,056	1,860	4,640	3,632	7,193	2,981	679	418	1,948	554	2,284
1956	230	91.9	234	405	3,375	1,316	1,399	5,162	161	55.7	31.3	25.5	1,035
1957	26.3	193	104	218	1,994	2,197	9,248	29,510	14,180	709	267	220	4,918
1958	3,890	10,530	5,729	6.049	4,472	4,269	3,819	23,890	2,440	2,012	452	2,458	5,856

SABINE RIVER AT LOGANSPORT, LA.

Monthly and yearly runoff, in thousands of acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1903	.....	.....	.....	.....	.....	.....	.....	.....	.....	221.0	87.90	14.40	.....
1904	71.90	33.20	28.60	28.90	51.40	60.80	272.0	127.0	115.0	54.40	21.20	11.70	876.0
1905	6.40	6.37	123.7	170.0	349.0	453.4	574.0	1,189.	629.9	816.2	254.5	26.20	4,599
1906	37.50	186.01	393.9	778.1	294.0	266.0	474.7	221.0	220.0	69.50	123.0	56.80	3,120
1907	83.00	25.50	245.0	351.0	84.40	197.0	118.0	499.0	443.0	57.30	9.90	5.09	2,120
1908	7.81	243.0	443.0	288.0	434.0	246.0	201.0	885.9	317.0	28.00	38.20	45.40	3,167
1909	32.40	20.10	50.60	50.80	150.0	132.0	66.60	31.20	26.80	6.82	3.91	2.68	574.0
1910	6.46	5.12	65.20	62.70	90.0	140.0	202.0	137.0	30.00	30.40	4.51	2.59	776.0
1911	2.08	2.11	6.00	19.20	19.30	30.90	199.0	124.0	7.86	62.10	11.50	5.00	489.0
1912	4.97	4.97	87.90	113.0	63.80	416.9	543.8	178.0	31.10	27.50	314.0	40.50	1,826
1913	6.00	5.62	13.80	50.70	96.60	416.0	223.0	65.80	26.10	231.0	11.90	127.0	1,270
1914	274.0	39.70	568.1	222.0	271.0	247.0	477.0	1,074	194.0	14.80	39.50	29.90	3,451
1915	14.60	17.90	188.0	382.0	472.1	469.0	249.9	981.0	75.00	133.0	384.3	275.0	3,642
1916	51.10	115.0	102.0	222.0	450.1	69.50	224.0	447.0	59.00	43.20	16.80	12.30	1,812
1917	8.12	23.20	43.00	73.20	134.0	125.0	79.70	53.40	66.60	71.90	26.30	37.50	742.0
1918	18.90	8.51	14.10	28.10	21.00	21.90	142.0	279.0	51.10	10.80	11.30	20.10	627.0
1919	12.10	68.40	196.0	402.0	277.0	259.0	221.0	110.0	136.00	282.0	223.0	137.0	2,320
1920	656.6	999.1	438.0	637.5	350.0	387.0	297.0	239.0	209.00	69.50	123.0	95.20	4,501
1921	49.20	71.40	153.7	385.8	225.3	322.8	648.5	532.7	122.8	225.8	20.21	15.00	2,773
1922	7.62	9.18	33.54	76.87	140.0	572.0	1,057	786.6	154.8	77.59	26.58	11.44	2,925
1923	5.94	40.95	33.17	68.74	343.2	380.8	445.7	194.1	153.2	29.18	5.33	52.45	1,753
1924	31.00	29.40	345.0	540.0	317.0	493.0	267.0	248.0	273.0	9.53	7.49	10.30	2,570
1925	7.63	5.93	13.30	50.50	29.00	33.30	29.60	112.0	13.00	4.82	2.91	5.95	308.0
1926	23.70	308.0	45.10	196.0	120.0	453.0	627.0	464.0	100.0	180.0	100.0	10.40	2,630
1927	16.20	30.40	182.0	290.0	295.0	545.0	684.0	367.0	107.0	93.20	77.30	7.01	2,670
1928	110.0	21.10	45.40	54.50	87.40	275.0	259.0	196.0	137.0	95.90	43.00	4.47	1,330
1929	11.70	86.30	287.0	579.0	326.0	334.0	169.0	307.0	444.0	35.20	4.92	20.10	2,600
1930	6.40	32.70	61.20	374.0	353.0	213.0	55.80	633.0	477.0	13.50	6.27	5.35	2,230

1931	30.70	28.00	188.0	184.0	134.0	310.0	127.0	239.0	45.00	22.30	11.30	9.76	1,330
1932	2.50	17.90	464.0	1,270	1,120	707.0	184.0	111.0	21.90	30.90	6.76	8.45	3,940
1933	5.85	6.13	44.50	430	293.0	460.0	363.0	311.0	129.0	352.0	139.0	24.20	2,560
1934	15.00	15.60	38.60	288	174.0	588.0	551.0	77.50	26.80	5.71	1.80	2.06	1,780
1935	2.45	39.42	165.6	177.3	379.6	185.0	127.5	1,075	319.2	164.8	12.58	13.91	2,662
1936	31.67	127.5	236.1	61.84	62.33	78.79	27.69	144.6	25.06	39.29	4.18	2.36	841.4
1937	64.17	35.88	82.63	484.1	276.1	407.8	251.5	39.82	23.83	7.52	6.35	9.96	1,690
1938	10.85	76.56	191.6	624.3	729.5	388.2	667.4	371.7	36.05	21.33	33.64	4.03	3,155
1939	2.52	24.34	28.30	236.2	361.0	408.0	139.6	79.78	29.21	12.88	2.36	1.39	1,326
1940	1.20	5.20	103.1	49.19	240.2	57.49	208.6	147.7	251.5	141.5	27.83	69.48	1,303
1941	13.73	423.8	976.9	774.9	305.4	571.6	264.4	533.5	494.8	411.3	45.26	60.59	4,876
1942	108.6	306.5	273.6	169.3	166.1	289.2	729.1	1,020	434.7	55.86	117.4	146.8	3,817
1943	30.63	54.42	72.84	252.5	79.26	95.80	184.7	95.56	743.3	94.68	8.04	4.89	1,717
1944	60.88	20.64	68.64	388.3	406.5	642.9	566.3	1,566	419.2	23.29	8.12	22.30	4,193
1945	8.63	33.92	224.2	899.1	335.9	1,316	2,048	174.0	298.8	582.3	57.54	18.34	5,997
1946	272.5	116.5	209.2	754.9	867.6	721.2	335.1	533.3	1,186	66.56	21.50	52.64	5,137
1947	35.17	667.9	422.3	477.0	271.3	460.4	486.5	327.1	80.99	46.38	8.71	35.77	3,320
1948	12.38	68.67	331.5	421.6	580.6	583.9	201.7	419.1	157.8	26.06	11.27	5.94	2,821
1949	5.65	21.43	33.70	191.7	355.2	439.2	268.3	220.2	102.0	121.8	90.08	33.07	1,882
1950	262.9	213.8	106.2	656.5	997.1	473.7	132.6	699.6	413.7	98.47	104.7	65.86	4,225
1951	32.42	32.14	30.42	94.40	237.6	236.6	120.3	74.76	114.9	41.70	6.45	11.47	1,033
1952	5.82	15.07	51.86	89.65	344.9	266.3	383.6	396.6	238	13.96	6.27	2.43	1,814
1953	2.28	7.07	136.1	143.4	211.9	430.2	156.2	1,372	291.1	78.07	33.57	29.51	2,891
1954	5.96	22.03	127.4	170.4	165.1	72.69	87.84	302.1	50.69	5.11	2.12	1.32	1,013
1955	8.76	154.3	64.94	114.4	257.7	223.3	428.0	183.3	40.38	25.7	119.8	32.99	1,654
1956	14.17	5.47	14.42	24.9	194.1	80.91	83.25	317.4	9.59	3.43	1.92	1.52	1,035
1957	1.62	11.46	6.39	13.41	110.7	135.1	550.3	1,815	843.6	43.58	16.42	13.08	3,561
1958	239.2	626.7	352.3	371.9	248.4	262.5	227.2	1,469	145.2	123.7	27.77	146.2	4,240

SABINE RIVER AT LOGANSPORT, LA.
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1903	850	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1904	850	6,090	Apr. 13, 1904	.....	1,210	0.249	3.37	876,000	1,211	3.37	878,900
1905	850	33,600	May 26, 1905	.....	6,352	1.31	17.74	4,599,000	7,017	19.60	5,080,000
1906	850	20,000	Jan. 5, 1906	.....	4,311	.887	12.04	3,120,000	3,946	11.07	2,857,000
1907	850	10,800	May 31, 1907	.....	2,930	.603	8.18	2,120,000	3,385	9.46	2,448,000
1908	850	30,100	May 18, 1908	.....	4,366	.899	12.24	3,167,000	3,564	10.01	2,587,000
1909	850	6,330	Feb. 19, 20, 1909	.....	792	.163	2.24	574,000	756	2.12	547,600
1910	850	7,540	May 24, 25, 1910	.....	1,070	.220	3.00	776,000	980	2.75	709,400
1911	850	6,980	Apr. 29, May 4, 1911	.....	675	.139	1.89	489,000	796	2.22	576,700
1912	850	16,200	Apr. 9, 1912	.....	2,515	.518	7.06	1,826,000	2,415	6.77	1,754,000
1913	850	11,900	Mar. 18, 1913	.....	1,760	.362	4.89	1,270,000	2,940	8.20	2,130,000
1914	850	36,000	May 10, 1914	.....	4,767	.981	13.33	3,451,000	3,854	10.78	2,790,000
1915	850	47,000	May 5, 1915	.....	5,030	1.04	14.05	3,642,000	5,096	14.24	3,689,000
1916	850	13,800	Feb. 3, 1916	.....	2,497	.514	7.01	1,812,000	2,229	6.25	1,618,000
1917	850	5,100	Mar. 11, 12, 1917	.....	1,030	.212	2.85	742,000	981	2.64	709,100
1918	850	8,890	May 11, 1918	.....	865	.178	2.41	627,000	1,190	3.33	861,800
1919	850	10,700	Jan. 6, 1919	.....	3,210	.661	8.96	2,320,000	5,720	15.97	4,141,000
1920	850	31,600	Jan. 27, 1920	.....	6,200	1.28	17.37	4,501,000	3,690	10.35	2,682,000
1921	850	41,600	Apr. 29, 1921	.....	3,830	0.788	10.71	2,773,000	3,521	9.85	2,549,000
1922	850	32,800	Apr. 2, 1922	.....	4,040	.832	11.35	2,925,000	4,080	11.46	2,955,000
1923	850	12,200	Apr. 8, 9, 1923	.....	2,421	.498	6.75	1,753,000	2,870	8.00	2,078,000
1924	588	14,000	June 3, 4, 1924	43	3,540	.729	9.91	2,570,000	3,021	8.45	2,192,000
1925	608	3,100	May 25, 1925	.....	425	.087	1.17	308,000	909	2.52	657,900

1926	628	23,000	Apr. 25, 1926	33	3,630	.747	10.13	2,630,000	3,425	9.56	2,479,000
1927	648	20,900	Apr. 19, 1927	60	3,720	.766	10.64	2,690,000	3,650	10.44	2,642,000
1928	668	9,860	Apr. 29, 1928	47	1,830	.377	5.12	1,330,000	2,117	5.92	1,537,000
1929	688	25,000	June 1, 1929	47	3,600	.741	10.06	2,600,000	3,206	8.97	2,320,000
1930	703	34,800	May 29, 1930	58	3,080	.634	8.60	2,230,000	3,286	9.16	2,378,000
1931	718	10,800	May 4, 1931	68	1,840	.379	5.13	1,330,000	2,164	6.04	1,567,000
1932	733	41,100	Feb. 23, 1932	34	5,420	1.12	15.17	3,940,000	4,829	13.52	3,516,000
1933	748	.....	.....	58	3,530	.727	9.86	2,560,000	3,550	9.92	2,570,000
1934	763	17,400	Mar. 8, 1934	23	2,470	.508	6.88	1,780,000	2,657	7.41	1,923,000
1935	788	36,000	May 8, 1935	34	3,678	.757	10.26	2,662,000	3,937	10.98	2,850,000
1936	808	8,400	Dec. 14, 1935	24	1,159	.238	3.25	841,400	866	6.88	628,800
1937	828	11,800	Jan. 29, 1937	24	2,334	.480	6.51	1,690,000	2,467	11.32	1,786,000
1938	858	25,700	Feb. 7, 1938	52	4,358	.897	12.19	3,155,000	4,049	5.32	2,931,000
1939	878	13,600	Mar. 4, 1939	16	1,831	.377	5.10	1,326,000	1,906	10.07	1,380,000
1940	898	8,060	Feb. 7, 1940	16	1,795	.369	5.04	1,303,000	3,592	10.07	2,608,000
1941	928	38,800	Nov. 27, 1940	94	6,735	1.39	18.82	4,876,000	5,733	16.02	4,150,000
1942	958	27,000	Apr. 24, 1942	144	5,273	1.09	14.74	3,817,000	4,540	12.69	3,286,000
1943	978	31,400	June 21, 1943	70	2,371	.488	6.63	1,717,000	2,361	6.59	1,709,000
1944	1008	34,300	May 6' 1944	74	5,776	1.19	16.18	4,193,000	5,937	16.64	4,310,000
1945	1038	92,000	Apr. 8, 1945	118	8,282	1.70	23.14	5,997,000	8,740	24.42	6,328,000
1946	1058	37,000	June 13, 1946	228	7,096	1.46	19.82	5,137,000	7,824	21.86	5,664,000
1947	1088	25,400	Nov. 22, 1946	106	4,585	.944	12.82	3,320,000	3,601	10.06	2,607,000
1948	1118	13,200	Feb. 15, 16, 1948	71	3,885	.800	10.88	2,821,000	3,401	9.52	2,469,000
1949	1148	9,380	Mar. 16, 1949	66	2,600	.535	7.26	1,882,000	3,321	9.28	2,404,000
1950	1178	28,900	Feb. 25, 1950	251	5,836	1.20	16.30	4,225,000	5,162	14.42	3,737,000
1951	1212	7,620	Feb. 22, 1951	59	1,427	0.294	3.97	1,033,000	1,396	3.88	1,011,000
1952	1242	13,000	Feb. 17, 1952	36	2,500	.514	7.00	1,814.000	2,601	7.29	1,887,000
1953	1282	40,900	May 19, 1953	36	3,993	.822	11.15	2,891,000	4,007	11.17	2,901,000
1954	1342	11,500	May 18, 1954	18	1,399	.288	3.91	1,013,000	1,499	4.20	1,085,000
1955	1392	12,600	Apr. 18, 1955	28	2,284	.470	6.38	1,654,000	2,016	5.63	1,460,000
1956	1442	13,700	May 8, 1956	19	1,035	.213	2.89	751,100	1,015	2.83	736,500
1957	1512	61,300	May 7, 1957	18	4,918	1.01	13.73	3,561,000	6,574	18.36	4,759,000
1958	1562	51,300	May 10, 1958	214	5,856	1.21	16.37	4,240,000	.....	.....	.....

TABLE 15. GAGING STATION RECORDS, BAYOU SAN PATRICIO NEAR NOBLE, LA.

Location—Lat 31°43′15″, long 93°42′25″, in lot 38, T. 9N., R. 13W., in Sabine Parish, at bridge on U. S. Highway 171, 1.6 miles downstream from Kansas City Southern Railway bridge, and 2.5 miles northwest of Noble.

Drainage area—154 sq. mi.

Gage—Water-stage recorder. Datum of gage is 169.73 ft. above mean sea level, datum of 1929, supplementary adjustment of 1941. Prior to Oct. 5, 1955, wire-weight gage and crest-stage indicator at same site and datum.

Average discharge—7 years, 123 cfs (89,050 acre-feet per year).

Extremes—1951-58: Maximum discharge, 15,400 cfs Sept. 21, 1958 (gage height, 16.04 ft.); no flow for many days in 1954, 1956-57.

BAYOU SAN PATRICIO NEAR NOBLE, LA.
Monthly and yearly runoff, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1952	0.49	1.52	60.6	78.9	237	228	408	87.5	13.1	12.7	4.37	0.18	93.4
1953	.10	1.07	4.70	24.6	294	891	484	1,414	3.84	8.13	4.84	.54	262
1954	.14	.54	10.3	52.8	28.7	8.84	70.7	344	1.51	.04	0	0	43.5
1955	0	.02	.18	2.13	25.5	126	223	64.5	1.50	14.4	115	5.41	48.3
1956	3.61	.45	2.78	7.76	213	35.5	226	51.8	4.69	.70	0	0	44.5
1957	0	.07	.20	20.6	151	194	618	375	273	10.3	.47	7.21	136
1958	13.1	566	126	285	160	265	78.1	209	90.2	17.4	1.95	983	231

BAYOU SAN PATRICIO NEAR NOBLE, LA.
Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1952	30	90	3,730	4,850	13,630	14,010	24,260	5,380	783	783	269	11	67,820
1953	6.1	63	289	1,510	16,300	54,760	28,790	86,960	229	500	298	32	189,700
1954	8.3	32	636	3,250	1,590	544	4,200	21,150	90	2.6	0	0	31,500
1955	0	1.2	11	131	1,420	7,770	13,290	3,970	89	883	7,090	322	35,000
1956	222	27	171	477	12,270	2,180	13,440	3,190	279	43	0	0	32,290
1957	0	4.4	12	1,260	8,400	11,940	36,770	23,080	16,230	631	29	429	98,790
1958	808	33,650	7,730	17,520	8,910	16,300	4,650	12,840	5,370	1,070	120	58,490	167,500

BAYOU SAN PATRICIO NEAR NOBLE, LA.
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1952	1242	1,380	Apr. 14, 1952	0.1	93.4	0.606	8.26	67,820	88.6	7.85	64,330
1953	1282	9,330	Apr. 30, 1953	.1	262	1.70	23.10	189,700	263	23.14	190,100
1954	1342	2,900	May 13, 1954	0	43.5	.282	3.84	31,500	42.6	3.75	30,800
1955	1392	1,200	Aug. 6, 1955	0	48.3	.314	4.26	35,000	48.7	4.31	35,380
1956	1442	2,280	Apr. 7, 1956	0	44.5	.289	3.93	32,290	43.9	3.88	31,890
1957	1512	3,930	Apr. 30, 1957	0	136	.883	12.02	98,790	195	17.16	141,000
1958	1562	15,400	Sept. 21, 1958	.1	231	1.50	20.40	167,500	.....	.....	.....

TABLE 16. GAGING STATION RECORDS, BAYOU SAN MIGUEL NEAR ZWOLLE, LA.

Location—Lat 31°39′10″, long 93°39′10″, in NE¼NW¼ sec. 25, T. 8 N., R. 13 W. at bridge on U. S. Highway 171, 1¾ miles northwest of Zwolle, and 3½ miles upstream from Bayou Scie.

Drainage area—113 sq. mi.

Gage—Water-stage recorder. Prior to March 4, 1949, staff gage at same site and datum.

Average discharge—10 years, 105 cfs, (76,020 acre-ft. per year).

Extremes—1948-58: Maximum discharge, 15,000 cfs June 3, 1950 (gage height, 15.75 ft.); no flow at times each year.

BAYOU SAN MIGUEL NEAR ZWOLLE, LA.
Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1949	0	1.13	8.90	449	304	381	72.8	16.4	22.1	4.99	1.81	0.49	104
1950	111	4.18	247	713	627	341	52.8	529	757	5.95	1.05	1.26	280
1951	0.11	0.85	15.5	95.9	139	268	69.0	86.0	3.24	1.02	.33	1.21	56.4
1952	.13	0	46.0	51.5	128	140	248	43.3	3.58	1.98	.03	0	54.8
1953	0	.01	0.284	365	281	678	398	1.122	1.42	1.70	1.02	.140	211
1954	0	0	2.47	41.9	12.7	2.96	105	138	1.76	0	0	0	25.5
1955	0	0	0	0	10.7	48.3	119	75.9	2.44	5.96	50.6	1.74	26.3
1956	.14	.01	1.55	2.40	188	25.4	95.5	20.9	10.0	6.51	0	0	28.3
1957	0	0	.02	16.0	139	213	497	359	200	12.6	.19	4.13	119
1958	2.55	448	76.0	258	115	247	59.3	78.0	50.4	7.34	1.97	424	147

BAYOU SAN MIGUEL NEAR ZWOLLE, LA.
Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1949	0	67	547	25,960	15,670	22,740	4,500	1,010	1,330	307	111	29	72,271
1950	6,830	249	15,170	43,810	34,800	20,950	3,140	32,510	45,020	366	64	75	203,000
1951	6.9	51	951	5,890	7,730	16,470	4,110	5,290	193	63	20	72	40,850
1952	8.1	0	2,830	3,170	7,380	8,600	14,760	2,660	213	122	2.0	0	39,750
1953	0	.4	17	2,240	15,590	41,680	23,660	69,000	85	105	63	8.3	152,400
1954	0	0	152	2,570	704	182	6,250	8,510	105	0	0	0	18,470
1955	0	0	0	0	592	2,970	7,060	4,660	145	367	3,110	103	19,010
1956	8.5	.4	95	147	10,800	1,560	5,680	1,280	598	400	0	0	20,570
1957	0	0	1.2	986	7,700	13,120	29,570	22,090	11,890	777	12	246	86,390
1958	157	26,650	4,670	15,840	6,390	15,200	3,530	4,790	3,000	451	121	24,260	106,100

BAYOU SAN MIGUEL NEAR ZWOLLE, LA.
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1949	1148	4,130	Mar. 26, 1949	0	99.8	.883	12.00	72,271	134	16.13	97,260
1950	1178	15,000	June 3, 1950	0	280	2.48	33.67	203,000	251	30.15	181,700
1951	1212	4,750	Mar. 29, 0951	0	56.4	.499	6.77	40,850	58.9	7.07	42,680
1952	1242	1,870	Apr. 14, 1952	0	54.8	.485	6.60	39,750	50.9	6.13	36,920
1953	1282	12,000	May 17, 1953	0	211	1.87	25.30	152,400	211	25.33	152,600
1954	1342	910	Apr. 18, 1954	0	25.5	.226	3.08	18,470	25.3	3.05	18,310
1955	1392	830	Apr. 13, 1955	0	26.3	.232	3.15	19,010	26.4	3.15	19,110
1956	1442	862	Apr. 8, 1956	0	28.3	.250	3.41	20,570	28.2	3.39	20,470
1957	1512	3,490	Apr. 30, 1957	0	119	1.05	14.34	86,390	163	19.57	117,900
1958	1562	7,060	Sept. 21, 1958	0	147	1.30	17.60	106,100	.....	.....	.....

TABLE 17. GAGING STATION RECORDS, BAYOU LA NANA NEAR ZWOLLE, LA.

Location—Lat 31°30′56″, long 93°39′04″, in SE¼ sec. 12, T. 7 N., R. 13 W., at bridge on State Highway 475, three-quarters of a mile downstream from Spring Branch, 4 miles upstream from mouth, and 8 miles south of Zwolle.

Drainage area—130 sq. mi.

Gage—Water-stage recorder. Datum of gage is 132.42 ft. above mean sea level (Louisiana Geodetic Survey bench mark; levels by Louisiana Department of Public Works). Auxiliary gage 0.4 mile upstream at same datum.

Extremes—1955-58: Maximum discharge, 5,700 cfs Sept. 22 (gage height, 21.34 ft.); no flow for many days 1956-57.

BAYOU LA NANA NEAR ZWOLLE, LA.
Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1956	.93	8.22	5.41	10.3	212	69.4	21.4	4.59	2.86	1.09	0.38	1.25	27.4
1957	.26	3.18	1.90	6.33	53.9	124	288	268	74.9	7.80	0.75	2.42	69.
1958	2.05	490	116	335	215	139	161	77.1	150	10.6	108	483	189

BAYOU LA NANA NEAR ZWOLLE, LA.
Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1956	57	489	333	632	12,210	4,270	1,270	282	170	67	23	74	19,880
1957	16	189	117	389	2,990	7,650	17,150	16,490	4,460	480	45	144	50,120
1958	126	29,150	7,150	20,620	11,950	8,520	9,550	4,740	8,940	650	6,650	28,710	136,800

BAYOU LA NANA NEAR ZWOLLE, LA.
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1956	1512	1,070	Feb. 4, 1956	0	27.4	0.211	2.86	19,880	26.6	2.78	19,320
1957	1512	2,000	May 2, 1957	0	62.9	0.532	7.24	50,120	119	12.45	86,220
1958	1562	5,700	Sept. 22, 1958	0.1	189	1.45	19.72	136,800	.....	.....	.....

TABLE 18. GAGING STATION RECORDS, BAYOU TORO NEAR TORO, LA.

Location—Lat 31°18′25″, long 93°31′56″, in SW¼ sec. 20, T. 4 N., R. 11 W., at bridge on State Highway 473, 0.2 mile upstream from Hanby Creek, 2.5 miles northeast of Toro, and 7.8 miles west of Hornbeck.

Drainage area—148 sq.mi.

Gage—Water-stage recorder. Datum of gage is 138.00 ft. above mean sea level (Louisiana Geodetic Survey bench mark; levels by Louisiana Department of Public Works).

Extremes—1955-58: Maximum discharge, 3,350 cfs Sept. 21, 1958, (gage height, 17.53 ft); minimum, 0.1 cfs Sept. 29, 30, Oct. 1-3, 1956; minimum gage height, 2.40 ft. Sept. 30, Oct. 1, 1956.

BAYOU TORO NEAR TORO, LA.
Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1956	8.35	9.18	17.7	36.1	222	42.4	30.8	11.3	11.0	2.62	0.92	0.76	31.9
1957	2.15	8.68	33.3	25.8	126	205	291	167	134	42.7	7.29	10.2	87.2
1958	20.5	589	176	273	187	147	228	121	73.4	24.4	198	459	207
1959	112	39.8	23.5	25.1	193	50.6	287	88.2	45.1	31.1	13.5	9.59	75.4

BAYOU TORO NEAR TORO, LA.
Monthly and yearly runoff, in thousands of acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1956	.514	.546	1.09	2.22	12.76	2.61	1.83	.692	.653	.161	.057	.045	23.18
1957	.132	.516	2.05	1.59	6.97	12.63	17.34	10.25	7.95	2.63	.448	.609	63.11
1958	1.26	35.02	10.80	16.77	10.41	9.06	13.55	7.41	4.37	1.5	12.15	27.32	149.6
1959	6.87	2.37	1.44	1.55	10.72	3.11	17.08	5.42	2.68	1.91	.832	.570	54.55

BAYOU TORO NEAR TORO, LA.
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1956	1512	1,140	Feb. 4, 1956	0.1	31.9	.222	3.01	23,180	32.7	3.09	23,730
1957	1512	1,770	May 2, 1957	.1	87.2	.606	8.23	63,110	148	14.0	107,500
1958	1562	3,350	Sept. 21, 1958	4.6	207	1.44	19.48	149,600	156	14.75	113,200
1959	1632	2,210	Apr. 18, 1959	5.4	75.4	.524	7.11	54,550	.....	.....	.....

TABLE 19. GAGING STATION RECORDS, SABINE RIVER NEAR MILAM, TEXAS[1]

Location—Lat 31°28′, long 93°45′, near right bank 104 ft. upstream from bridge on State Highway 21, 2.8 miles downstream from Patroon Bayou, 6.5 miles northeast of Milam, Sabine County, 7.2 miles upstream from Palo Gaucho Bayou, and at mile 195.

Drainage area—6,543 sq. mi.

Gage—Water-stage recorder. Datum of gage is 97.96 ft. above mean sea level, datum of 1929, supplementary adjustment of 1941. Oct. 9, 1923 to Aug. 31, 1925, staff gage 7.4 miles downstream at different datum. Jan. 19, 1939, to Dec. 21, 1945, wire-weight gage 104 ft. downstream at present datum.

Average discharge—19 years (1939-58), 5,630 cfs (4,076,000 acre-ft. per year).

Extremes—1923-25, 1939-58: Maximum discharge, 83,400 cfs, Apr. 12, 1945 (gage height, 48.87 ft), minimum, 25 cfs, Oct. 14-19, 1956.

Maximum stage known since at least 1884, that of Apr. 12, 1945. Flood of about July 28, 1933, reached a stage of 48 ft., from information by former observer. Flood o 1884 reached a stage about 2 ft. lower than that of 1945 at ferry about 10 miles upstream, from information by local resident.

[1]Published as "at Sabinetown" 1925-25.

SABINE RIVER NEAR MILAM, TEXAS

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1924	2,120	2,960	14,600	16,600	10,600	15,400	8,090	8,710	13,000	310	194	221	7,740
1925	241	167	349	2,560	862	1,150	676	2,030	370	142	72.0	75	728
1939	.....	.....	.....	5,957	12,740	10,130	3,395	2,780	967	306	117	61.3	.....
1940	167	121	4,919	2,340	11,480	1,709	5,301	4,476	6,378	2,929	1,161	1,517	3,501
1941	265	9,618	27,120	19,790	8,925	13,050	5,363	13,240	13,710	9,772	1,087	1,276	10,310
1942	2,596	12,830	7,350	4,808	5,108	7,891	11,710	18,210	8,875	1,319	1,662	2,819	7,094
1943	536	961	1,110	4,349	1,815	2,113	3,311	1,711	9,431	4,225	213	123	2,487
1944	884	448	945	7,719	8,241	13,780	12,760	32,820	12,460	546	233	947	7,656
1945	182	1,154	6,118	21,490	9,727	19,550	43,450	4,617	3,545	11,300	1,770	451	10,260
1946	5,374	2,509	4,553	18,320	23,230	16,940	9,331	11,840	22,700	2,135	640	1,006	9,782
1947	693	10,200	10,560	16,580	7,211	10,930	11,120	6,238	1,621	900	193	607	6,403
1948	237	1,247	5,817	7,581	14,950	11,430	6,442	6,537	3,479	572	234	126	4,855
1949	110	510	746	6,439	9,699	11,000	6,878	4,020	2,276	1,893	1,922	698	3,815
1950	6,002	4,204	4,421	18,490	20,400	15,000	3,207	15,570	16,080	1,920	1,812	1,141	8,959
1951	705	588	661	2,129	5,106	5,700	3,735	1,925	1,875	952	153	261	1,961
1952	130	276	1,471	1,711	7,507	6,215	8,897	7,498	4,446	451	200	68.2	3,214
1953	54.9	150	1,974	2,879	6,232	14,340	3,670	37,210	9,653	1,431	938	573	6,629
1954	140	351	2,430	3,438	3,685	1,461	2,667	7,194	1,003	125	62.0	36.8	1,877
1955	76.3	2,431	1,036	1,794	4,984	4,400	9,315	3,978	1,063	688	3,232	540	2,771
1956	326	135	297	472	4,647	1,734	3,346	5,838	293	117	50.7	36.6	1,429
1957	32.1	206	122	313	2,797	3,276	10,540	37,800	17,450	1,717	369	241	6,257
1958	3,709	13,670	9,306	9,150	6,629	5,911	4,297	24,530	3,779	2,236	857	7,967	7,681

SABINE RIVER NEAR MILAM, TEXAS
Monthly and yearly runoff, in thousands of acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1924	131.0	176.0	897.0	1,020	613.0	949.0	481.0	536.0	773.0	19.10	11.90	13.10	5,620
1925	14.80	9.94	21.40	158.0	47.90	71.00	40.20	125.0	22.00	8.74	4.43	4.46	528.0
1939	.....	.....	.....	366.3	707.5	622.9	202.0	171.0	57.53	18.81	7.18	3.65	.....
1940	10.26	7.18	302.5	143.9	660.5	105.1	315.4	275.2	379.5	180.1	71.38	90.29	2,541
1941	16.27	572.3	1,668	1,217	495.6	802.2	319.1	814.2	816.0	600.8	66.82	75.95	7,464
1942	159.6	763.7	452.0	295.7	283.7	485.2	697.0	1,120	528.1	81.08	102.2	167.7	5,136
1943	32.97	57.18	68.25	267.4	100.8	129.9	197.0	105.2	561.2	259.8	13.11	7.34	1,800
1944	54.35	26.63	58.12	474.6	474.0	847.5	759.5	2,018	741.3	33.60	14.32	56.33	5,558
1945	11.17	68.69	376.2	1,321	540.2	1,202	2,586	283.9	211.0	694.7	108.9	26.84	7,431
1946	330.4	149.3	279.9	1,126	1,290	1,041	555.2	727.8	1,351	131.3	39.33	59.89	7,081
1947	42.64	606.8	649.2	1,019	400.5	672.3	661.9	383.5	96.43	55.32	11.86	36.11	4,636
1948	14.55	74.18	357.7	466.1	859.9	702.6	383.3	402.0	207.0	35.15	14.41	7.53	3,524
1949	6.78	30.34	45.88	395.9	538.7	676.6	409.2	247.2	135.4	116.4	118.2	41.56	2,762
1950	369.0	250.2	271.8	1,137	1,133	922.4	190.8	957.4	956.8	118.1	111.4	67.88	6,486
1951	43.34	34.96	40.63	130.9	283.6	350.5	222.2	118.4	111.6	58.56	9.38	15.51	1,420
1952	8.00	16.45	90.42	105.20	431.80	382.2	529.4	461.1	264.6	27.70	12.28	4.06	2,333
1953	3.38	8.95	121.4	177.0	346.1	881.5	218.4	2,288	574.4	87.97	57.65	34.07	4,799
1954	8.62	20.86	149.4	211.4	204.7	89.83	158.7	442.3	59.69	7.67	3.81	2.19	1,359
1955	4,690	144.7	63.68	110.3	276.8	270.6	554.3	244.6	63.26	42.28	198.7	32.16	2,006
1956	20.04	8.02	18.27	29.05	267.3	106.6	199.1	359.0	17.42	7.20	3.12	2.18	1,037
1957	1.97	12.23	7.53	19.22	155.3	201.5	627.0	2,324	1,039	105.6	22.71	14.34	4,530
1958	228.1	813.2	572.2	562.6	368.1	363.5	255.7	1,508	224.8	137.5	52.68	474	5,560

SABINE RIVER NEAR MILAM, TEXAS
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1924	588, 1312	33,500[1]	June 4, 1924	110	7,740	1.15	15.61	5,620,000	6,145	12.40	4,460,000
1925	608, 1312	7,420[1]	Jan. 17, 1925	.....	728	.108	1.46	528,000	.....	.....	.....
1939	878, 1312	17,700[1]	Feb. 20, 1939	.....	.....	.....	.....	.....	3,421	7.10	2,477,000
1940	898	20,300	Feb. 12, 1940	32	3,501	.535	7.28	2,541,000	6,168	12.83	4,478,000
1941	928	54,200[1]	Nov. 29, 1940	126	10,310	1.58	21.39	7,464,000	9,093	18.86	6,583,000
1942	958	25,100[1]	Nov. 5, 1941	251	7,094	1.08	14.71	5,136,000	5,413	11.22	3,919,000
1943	978	21,700	July 1, 1943	107	2,487	.380	5.15	1,800,000	2,460	5.11	1,781,000
1944	1008	52,700[1]	May 7, 1944	102	7,656	1.17	15.94	5,558,000	8,093	16.84	5,875,000
1945	1038	83,400	Apr. 12, 1945	139	10,260	1.57	21.29	7,431,000	20,680	22.16	7,734,000
1946	1058	36,400	Feb. 12, 1946	312	9,782	1.49	20.30	7,081,000	10,530	21.84	7,620,000
1947	1088	22,300	Jan. 20, 1947	141	6,403	.978	13.29	4,636,000	5,226	10.84	3,783,000
1948	1118	18,800	Feb. 15, 16, 1948	93	4,855	.742	10.08	3,524,000	4,354	9.05	3,161,000
1949	1148	17,400	Mar. 29, 1949	81	3,815	.583	7.91	2,762,000	4,932	10.23	3,570,000
1950	1178	42.400	June 5, 1950	377	8,959	1.37	18.59	6,486,000	.....	.....	.....
1951	1212	16,100	Mar. 30, 1951	81	1,961	.300	4.07	1,420,000	1,955	4.06	1,416,000
1952	1242	17,000	Apr. 25, 1952	53	3,214	.491	6.69	2,333,000	3,240	6.75	2,352,000
1953	1282	69,100	May 20, 1953	49	6,629	1.01	13.78	4,799,000	6,691	13.90	4,844,000
1954	1342	13,800	May 17, 1954	26	1,877	.287	3.90	1,359,000	1,925	3.99	1,393,000
1955	1392	13,900	Apr. 18, 1955	33	2,771	.423	5.74	2,006,000	2,541	5.27	1,839,000
1956	1442	13,100	May 11, 1956	26	1,429	.218	2.98	1,037,000	1,395	2.91	1,013,000
1957	1512	59,400	May 11, 1957	25	6,257	.956	13.01	4,530,000	8,456	17.56	6,122,000
1958	1562	40,800	May 16, 1958	304	7,681	1.17	15.91	5,560,000	.....	.....	.....

[1]Maximum observed.
NOTE:—Published as "at Sabinetown" 1924-25.

TABLE 20. GAGING STATION RECORDS, BAYOU DUPONT NEAR ROBELINE, LA.

Location—Lat 31°42′15″, long 93°19′38″, in sec. 6, T. 8 N., R. 9 W., near left bank at bridge, on State Highway 120, 1.9 miles north of Robeline and 5.0 miles upstream from Little River.

Drainage area—35.1 sq. mi.

Gage—Water-stage recorder. Datum of gage is 123.51 ft. above mean sea level (levels by Soil Conservation Service).

Extremes—1957-59: Maximum discharge, 2,800 cfs Jan. 21, 1958; no flow for many days each year.

BAYOU DUPONT NEAR ROBELINE, LA.
Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1957	.....	.....	.....	.....	28.0	43.0	130	53.7	28.2	0.72	0.003	0.11	.....
1958	0.50	151	30.9	90.5	58.6	73.6	13.9	9.30	30.4	.88	6.71	112	47.8
1959	15.2	4.47	1.38	2.03	40.2	33.8	57.6	53.5	33.8	1.61	1.38	.18	20.2

BAYOU DUPONT NEAR ROBELINE, LA.
Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1957	.....	.....	.....	.....	1,550	2,640	7,740	3,300	1,680	44	0.2	6.7	.....
1958	31	9,010	1,900	5,560	3,260	4,520	828	572	1,810	54	413	6,670	34,630
1959	936	266	85	125	2,230	2,080	3,430	3,290	2,010	99	85	11	14,650

BAYOU DUPONT NEAR ROBELINE, LA.
Yearly discharge, in cubic feet per second

Water year	W. S. P. no.	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day	Mean	Square mile	Runoff		Mean	Runoff	
		Discharge	Date				Inches	Acre-feet		Inches	Acre-feet
1957	1511	892	Apr. 28, 1957	0	.....	.....	.....	.....	.....	.....	.....
1958	1561	2,800	Jan. 21, 1958	0	47.8	1.36	18.50	34,630	34.5	13.34	24,970
1959	1631	710	Apr. 18, 1959	0	20.2	.575	7.81	14,650	.....	.....	.....

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